MAMMALS of Northern Alaska

James W. Bee
and
E. Raymond Hall

University of Kansas
Museum of Natural History

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NORTHERN ALASKA
On the Arctic Slope

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Miscellaneous Publication No. 8

Mammal on front of the cover is a Polar Bear

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NORTHERN ALASKA
On the Arctic Slope

By

James W. Bee and E. Raymond Hall

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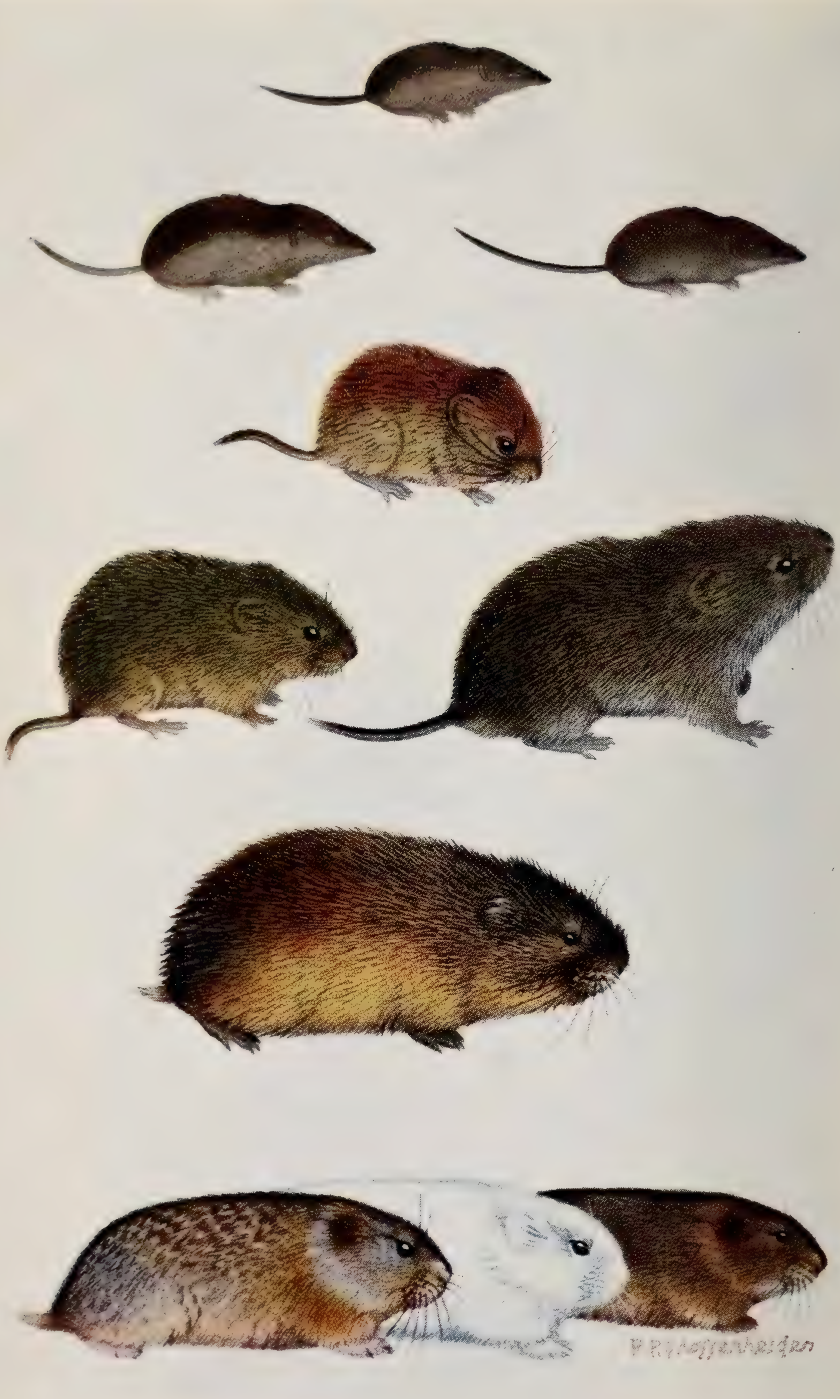

EXPLANATION OF COLORED FRONTISPIECE

All Mammals ½ Natural Size

Sorex cinereus ugyunak

Summer-adult pelage, No. 43175
K.U., ♂, September 2, 1951,
Umiat, Alaska.

Sorex arcticus tundrensis
(left)
Summer-adult pelage, No. 43214
K.U., ♀, September 3, 1951,
Umiat, Alaska.

Sorex obscurus obscurus
(right)
Summer-adult pelage, No. 43198
K.U. ♂, August 9, 1951,
Bettles, Alaska.

Clethrionomys rutilus dawsoni

Autumnal-adult pelage, No. 43430
K.U., ♂, August 15, 1951,
Chandler Lake, Alaska.

Microtus miurus muriei
(left)
Late summer-adult pelage, No. 43733
K.U., ♀, September 2, 1951,
Umiat, Alaska.

Microtus oeconomus gilmorei
(right)
Autumnal-adult pelage, No. 43631
K.U., ♀, August 18, 1951,
Chandler Lake, Alaska.

Lemmus trimucronatus alascensis

Breeding-adult pelage, No. 50818
K.U., ♀, June 19, 1952,
Point Barrow, Alaska.

Dicrostonyx groenlandicus rubricatus

(left)
Spring-adult pelage, No.
43322 K.U., ♂, July 7,
1951, Topagaruk, Alaska.

(center)
Winter-adult pelage,
from various sources.

(right)
Post-juvenal pelage, No.
43326 K.U., ♂, July 25,
1951, Kaolak, Alaska.

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INTRODUCTION

On the Arctic Slope of Alaska—meaning from the crest of the Brooks Range of mountains northward to the Arctic Ocean—there are only a few kinds of mammals, and the numbers of each kind fluctuate widely over periods of three to nine years. The same can be said of the fauna of any part of the Arctic region in comparison with the fauna of the Tropical region.

The actual number of kinds of land mammals, say, in an area 25 miles square, is fewer than 17 immediately south of Point Barrow, Alaska, as contrasted with about 55 at Lawrence, Kansas, in the Temperate region, and more than 140 in the Tropical region, immediately adjacent to Panama City, Panama.

Why are there so few kinds in the Arctic region? Continuous cold for a long part of each year so shortens the growing season that there are few kinds of foods readily available and but few places to live and so only a few species can exist. Bats, for example, subsist mostly on insects; but at Point Barrow insects are readily obtained in only two of the twelve months and so no bats live there. There are no trees there and consequently no arboreal mammals such as make up a sizable part of the mammalian fauna farther south. There are not even any bushes five to ten feet tall that provide habitat for such mammals as chipmunks and wood rats farther south. The permafrost, several hundred to more than a thousand feet deep, excludes the variety of species that burrow and live in holes in the ground farther south. Lakes and streams, although covering half the surface of the area around Point Barrow, are open only briefly in the short summer and for most of the year are frozen solid; fresh-water mammals, therefore, have no place to live and so the river otter, mink, muskrat and water shrew are missing.

It is only the surface of the ground that is available to mammals, and of course, for a brief period in summer, the upper six to eight inches of soil that thaws out. It seems that the small number of species of mammals is proportional to the small number of habitats; it is correct to say that there are few species because there are few habitats.

The fluctuations in number of individuals in each of several species is great. For example, in a summer when brown lemmings are scarce, a naturalist walking for days on the tundra might see only one or two individuals, or none at all. On the same area a year later a dozen individuals might be seen, and two years later a hundred. Three years later thousands might be seen—four to a dozen at any given instant scurrying to hiding places ahead of the observer, reminding him of dry autumn leaves moving ahead of a strong breeze. The increase is gradual, but gains momentum, over a three year period until the peak is reached. Then, perhaps early in spring, in only one or a few months, the crash reduces the numbers to a fraction of one per cent of the winter population.

The causes? 1) Starvation because all of the food has been eaten. 2) Natural enemies concentrate on the easy-to-catch prey. 3) Disease spreads rapidly because of overcrowding, and flames like a torch to destroy nearly all within reach before the fire burns itself out. One or another of these causes can be detected in any crash and sometimes all three causes operate together. Of course there are other causes, such as floods and cold, depending on the time and place. This gradual build-up in numbers and ensuing sudden crash recur so regularly that the time of the crash and the beginning of the build-up can be predicted accurately two years or more in advance.

A marked tendency to gradual increase and sudden crash is seen in the Temperate region too, but the duration of the period of increase is more variable and many of the upward trends in numbers stop short of the expected peaks. Therefore, the time when a peak will occur cannot be predicted accurately. Consequently the term "cyclic," implying regularity, is less applicable to fluctuations in numbers of individuals of a species, especially in the Temperate region, than was originally supposed and some students, therefore, have used instead the adjective "multiannual." Irrespective of the adjective applied to these fluctuations, they are of lesser magnitude and less frequent in progressively more southern regions until in the Tropics there is no detectable fluctuation in most species.

Precisely why this fluctuation does not occur in the Tropics is unknown but it is tempting to speculate from the basis of fact that is available. One basis is the number of species of carnivorous mammals and small herbivorous mammals arranged according to life-zones (see table 1).

When the population of any one of the 35 smaller herbivorous species in the Tropical Life-zone begins to increase it may be that the carnivorous species concentrate on that particular prey species because of the ease with which it can be obtained. Because the carnivores are concentrating on only 1/35 of the smaller herbivorous species, the carnivores exert a checking effect that may be sufficient to control the particular species of herbivore.

TABLE 1.

Region	Life-zones	Number of smaller herbivorous mammals	Number of carnivorous mammals	Nature of fluctuations in populations
Arctic region	Arctic *Point Barrow*	5	7	cyclic
	Hudsonian			
	Canadian			
Temperate region	Transition			
	Upper Austral *Lawrence, Kans.*	22	15	multiannual
	Lower Austral			
Tropical region	Upper Tropical			
	Lower Tropical *Panama City*	35	18	none

In the Arctic Life-zone, predation by carnivores is certainly insufficient to stem the increase in numbers of any given species of small herbivore. Were it otherwise these herbivores probably would not reach their peaks at relatively regular intervals. Also, population density of an Arctic carnivorous mammal itself fluctuates more or less cyclically lagging approximately one year behind that of its principal prey species in its increase, peak, and crash. This is evidence that the size of the population of the carnivorous species is actually determined by the size of the population of the prey species instead of *vice versa.* When the several carnivorous species concentrate in their feeding on the particular herbivorous species of small mammal that is increasing in numbers, the carnivores of the Arctic Life-zone are concentrating on roughly 1/5 of the total population of small herbivores—not on only 1/35 as has been postulated concerning the Lower Tropical Life-zone. Be that as it may, in the Arctic the carnivores do not prevent peaks in abundance of species of small herbivores even if they do so in the Tropical Life-zone. In the life-zones of the geographically intermediate Temperate region the carnivores could be supposed to exert a checking effect on any increases that get underway in the species of smaller herbivorous mammals and the checking effect would then sometimes greatly delay or even prevent a species of small herbivore there from reaching its peak in population size.

A word of caution is in order here: Because the effect of predation seems to differ so much, according to life-zone, conclusions from studies made of predator-prey relationships in one life-zone cannot be applied safely in another life-zone, but only in the same life-zone where made. We recall the names of some generally careful naturalists who have been careless in this regard.

In any life-zone, but especially in the Tropical Life-zone, there are biological relationships other than predation which may have much to do with stabilizing the population size of species of small herbivores. For example, the larger number of kinds of herbivores than in life-zones polewards, may result in various types of competition between the herbivores themselves. Also, as a general rule, a given species has fewer young per litter in the Tropical Life-zone than it has in a life-zone nearer either pole.

But to return to conditions peculiar to the polar regions—conditions that have influenced the mammals of the Arctic: at Point Barrow there is no sun for a period of more than two months in winter and for a like period in summer the sun shines for 24 hours per day. This would be expected to influence the growth of the mammals and possibly the length of their period of growth. Certainly the continuous sunlight in summer rapidly increases the amount of vegetation that is the staff of life of the native species of small herbivorous mammals.

A climatic factor that may greatly influence mammals of the Arctic Slope is the slight amount of precipitation. At Point Barrow the yearly average is less than five inches, and as a result the layer of snow that blankets the ground for most of the year is thin. Therefore the snow melts quickly with the advent of warm weather and consequently there is more time for plant growth than would be the case if the snow were deep. More plant growth means more food for the primary consumers, herbivores, which are situated low-down toward the broad base of the food-pyramid. Furthermore, the large herbivore, the caribou, more easily finds its natural winter food—lichens, mosses and other plants—beneath a thin rather than a thick blanket of snow. Also the muskox, before it was exterminated in northern Alaska, may have benefited from the thinness of the cover of snow in the same way that is postulated for the caribou but to an even greater degree.

Information about geography and climate and other background information is to be found toward the back of this booklet because we judge that most users will want to consult first the account of some one of the species.

CHECK-LIST OF THE MAMMALS OF THE ARCTIC SLOPE OF NORTHERN ALASKA

There are 7 orders, 18 families, 32 genera, and 42 species one of which has 2 subspecies in the area.

Order INSECTIVORA—Insectivores

Family Soricidae—Shrews

		page
Sorex cinereus ugyunak Anderson and Rand	Cinereous Shrew	15
Sorex arcticus tundrensis Merriam	Arctic Shrew	22
Sorex obscurus obscurus Merriam	Dusky Shrew	28

Order LAGOMORPHA—Hares, Rabbits, Pikas

Family Leporidae—Hares, Rabbits

Lepus othus othus Merriam	Tundra Hare	31

Order RODENTIA—Rodents

Family Sciuridae—Squirrels

Marmota caligata broweri Hall and Gilmore	Hoary Marmot	35
Spermophilus undulatus kennicottii (Ross)	Arctic Ground Squirrel	43

Family Cricetidae—Cricetid Mice and Rats

Dicrostonyx groenlandicus rubricatus (Richardson)	Collared Lemming	57
Lemmus trimucronatus alascensis Merriam	Brown Lemming	74
Lemmus trimucronatus, new subspecies	Brown Lemming	109
Clethrionomys rutilus dawsoni (Merriam)	Red-backed Vole	113
Microtus oeconomus gilmorei Setzer	Tundra Vole	124
Microtus miurus muriei Nelson	Singing Vole	136

Family Erethizontidae—Porcupines

Erethizon dorsatum myops Merriam	Porcupine	156

Order CETACEA—Whales, Porpoises, Dolphins

Family Monodontidae—Monodontids

Delphinapterus leucas (Pallas)	White Whale	158
Monodon monoceros Linnaeus	Narwhal	159

Family Delphinidae—Delphinids

Grampus rectipinna (Cope)	Pacific Killer Whale	162
Phocoena vomerina Gill	Pacific Harbor Porpoise	162

Family Eschrichtidae—Gray Whale and Allies

Eschrichtius gibbosus (Erxleben) Gray Whale 164

Family Balaenidae—Baleen Whales

Balaena mysticetus Linnaeus Bowhead Whale 165

Order CARNIVORA—Carnivores

Family Canidae—Wolves, Coyote, Foxes

Canis latrans incolatus Hall Coyote 168
Canis lupus tundrarum Miller Gray Wolf 170
Alopex lagopus innuitus (Merriam) Arctic Fox 180
Vulpes fulva alascensis Merriam Red Fox 184

Family Ursidae—Bears

Ursus horribilis richardsoni Swainson Grizzly Bear 188
Ursus americanus americanus Pallas Black Bear 198
Thalarctos maritimus maritimus (Phipps) Polar Bear 200

Family Mustelidae—Mustelids

Mustela erminea arctica (Merriam) Ermine 203
Mustela rixosa eskimo (Stone) Least Weasel 207
Mustela vison ingens (Osgood) Mink 210
Gulo luscus luscus (Linnaeus) Wolverine 212
Lutra canadensis yukonensis Goldman River Otter 215

Family Felidae—Cats

Lynx canadensis canadensis Kerr Lynx 217

Order PINNIPEDIA—Pinnipeds

Family Otariidae—Eared Seals

Callorhinus ursinus cynocephalus (Walbaum) Northern Fur Seal 219

Family Odobenidae—Walrus

Odobenus rosmarus divergens (Illiger) Walrus 220

Family Phocidae—Earless Seals

Phoca vitulina richardii (Gray) Harbor Seal 222
Phoca fasciata Zimmermann Ribbon Seal 225
Phoca hispida beaufortiana Anderson Ringed Seal 226
Erignathus barbatus nauticus (Pallas) Bearded Seal 227

Order ARTIODACTYLA—Even-toed Ungulates

Family Cervidae—Deer and Allies

Alces alces gigas Miller Moose 228
Rangifer arcticus stonei J. A. Allen Barren-ground Caribou 232

Family Bovidae—Bovids

Ovibos moschatus moschatus (Zimmermann) Muskox 253
Ovis dalli dalli Nelson Dall Sheep 255

Sorex cinereus ugyunak Anderson and Rand
Cinereous Shrew (Ugrugnak)

Sorex cinereus ugyunak Anderson and Rand, Canadian Field-Nat., 59:62, October 16, 1945, type from Tuktuk (Tuktuyaktot), NE side Mackenzie River Delta, S of Toker Point, Mackenzie. (Also Rausch, 1950c:465; 1951: 164; 1953b:94.)

Sorex forsteri, Murdock, *in* Expedition to Point Barrow, Alaska, Exec. Doc. No. 44 (48th Congress, 2nd Session) by P. H. Ray, p. 102, 1885. (Also Turner, 1886:205; Nelson and True *in* Nelson, 1887:271.)

Sorex personatus streatori, W. Stone, Proc. Acad. Nat. Sci. Philadelphia, 52:43, March 24, 1900.

Sorex cinereus hollisteri, A. M. Bailey and Hendee, Jour. Mamm., 7:13, February 15, 1926. (Also Jackson, 1928:55; Dufresne, 1946:159.)

Sorex cinereus cinereus, Jackson, N. Amer. Fauna, 51:40, July 24, 1928.

Sorex cinereus, Burt and Grossenheider, A field guide to the mammals, Houghton Mifflin Company, Boston, p. 4, 1952.

Description.—See colored frontispiece. Average and extreme measurements of 5 males and 8 females from Chandler Lake, all showing slight wear on teeth, are, respectively, as follows: Total length, ♂ 87 (85-91), ♀ 90 (83-98); tail, 31 (28-33), 30 (28-34); hind foot, 11 (11-12), 11 (11-12); weight, 4.2 (4.0-5.0) grams, 3.4 (3.0-4.0—all non-pregnant) grams; condylobasal length of skull, 15.7 (15.5-16.0), 15.5 (15.1-15.9); maxillary breadth, 4.3 (4.2-4.3), 4.2 (4.1-4.3). In summer pelage, back between Fuscous-Black (Capitalized color terms after Ridgway, Color Standards and Color Nomenclature, Washington, D. C., 1912) and Mummy Brown; sides Drab to Buffy Brown; underparts Pale Smoke Gray; tail bicolor, above like back and below like underparts nearly to tip where darker more nearly like back. Winter pelage (October and April) grayer than in summer. Snout long and sharp-pointed; eyes minute; 5 toes, each with a claw, on each foot; skull lacking zygomatic arches; 32 teeth; third unicuspid tooth not smaller than fourth (see drawing of skull).

Differs from S. *a. tundrensis* in smaller average size of external parts; condylobasal length of skull less than 16.7 mm; maxillary breadth less than 4.5; no postmandibular canal; unicuspid teeth, especially the first, with indentation on anteromedial part of crown; weight of males and non-pregnant fe-

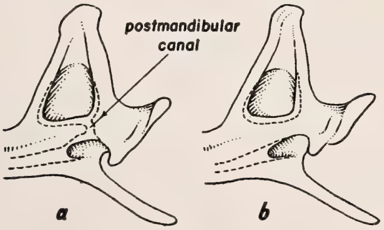


Fig. 1. Showing presence of postmandibular canal in *Sorex arcticus* and absence of this canal in *Sorex cinereus.*

a. Sorex arcticus tundrensis, same specimen shown in fig. 4. × 5½.
b. Sorex cinereus ugyunak, same specimen shown in fig. 2. × 7.

males less than 5.5 grams. Differs from S. *o. obscurus* in smaller size (no overlap in any measurements of our specimens); also *ugyunak* ordinarily saddle-backed (sides colored differently than back or belly) instead of bicolored (sides colored like back) and third unicuspid tooth always as large as, or larger than, fourth unicuspid instead of smaller than fourth. S. *c. ugyunak* is the smallest mammal native to the Arctic Slope.

Remarks.—Outstanding external differences of this subspecies, in comparison with both S. *c. cinereus* and S. *c. hollisteri,* are shorter tail and paler sides giving a saddle-back effect. Also the upper side of the tail is paler than in S. *c. cinereus* and the underparts are much paler than in S. *c. hollisteri.* All of the specimens examined by us have short tails. Occasional specimens from places where the

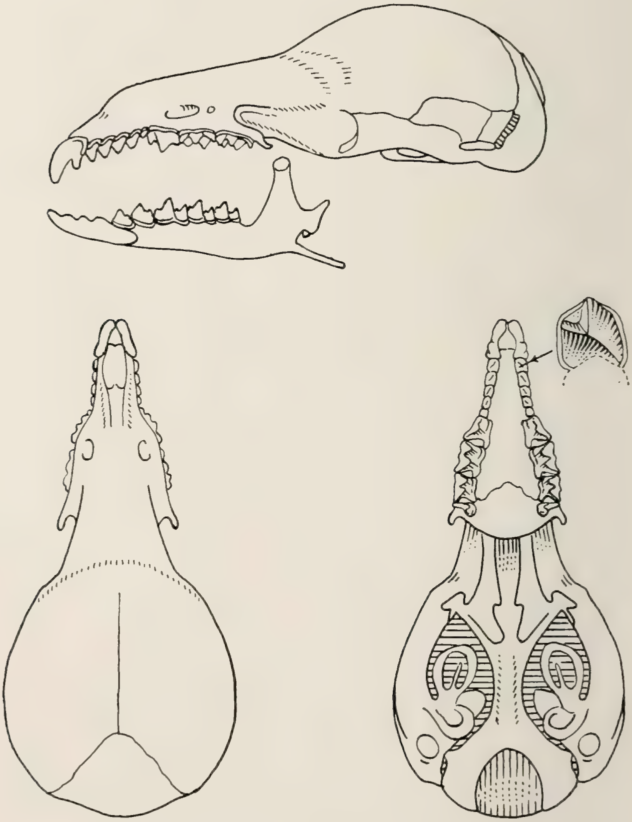


FIG. 2. Skull of *Sorex cinereus ugyunak*, Kaolak, 160°14′51″, 69°56′00″, 178 ft., July 23, 1951, No. 43166 KU, ♀. × 4.

geographic range approaches that of S. c. *cinereus* have darker sides, although not so dark as the back. Examples are the specimen from Lake Schrader and two of the 13 from Chandler Lake. The two specimens from Kaolak also have dark sides but this may represent intergradation with S. c. *hollisteri*.

S. *cinereus* occurs as one relatively uniform subspecies from Arizona to the south edge of the Brooks Range and then, in a linear distance of approximately 50 miles the species changes markedly. Within this area of abrupt change from timber (providing much overhead protection for the shrew) to tundra (providing scant overhead protection) the tail becomes shorter. This shortening of the tail occurs also in some other mammals in the belt of transition between deciduous forest and prairie in the temperate region. Shorter ears and tail are associated with low temperature; witness the short ears and tail of *Dicrostonyx* which is exposed to the most rigorous conditions of the Arctic region. The color change from dark in S. c. *cinereus* to light in S. c. *ugyunak* is perhaps a response to the Arctic climate.

This species occurs in various plant and animal communities throughout the Arctic Slope but never was trapped in great numbers by us from any one of these communities.

The cinereous shrew occurs in many physiographic types. It favors valley- and canyon-floors, benchlands, swales that lead into areas of greater relief, or flat country having soil polygons.

Of the three shrews that inhabit the Arctic Slope, the cinereous shrew is the most aquatic. It regularly uses trails in which there is water. This adaptation to water is useful because there is much water in the Arctic soils. These shrews are active in freezing temperatures.

The cinereous shrews are more commonly found in low wet meadows, than elsewhere. In these meadows the sedge, *Carex aquatilis* Wahl. is dominant and *Carex lugens* Holm and the grasses *Arctogrostis latifolia* (R. Br.) Griseb., *Poa arctica* R. Br., *Poa glauca* Vahl, *Calamogrostis neglecta* (Ehrh.) and *Trisetum spicatum* (L.) Richt. are subdominant. Also in these meadows are *Carex Kelloggii* W. Boott, *Carex physocarpa* Presl. and *Carex podocarpa* R. Br. On benchlands, particularly in dryer areas of a meadow, where *Eriophorum* and dwarf willow are present, sedges are dominant and *Calamogrostis canadensis* (Michx.) Beauv. is subdominant. In swales that are on steep hillsides the dominant grasses seem to be *Festuca altaica* Trin. and *Poa arctica* with a species of *Calamogrostis* associated. The cinereous shrew has been found also in almost all communities in which microtines were found. At Point Barrow, *Arctophila fulva* was the only grass where a cinereous shrew was captured. Because the communities of plants and animals on the Arctic Slope are ill-defined and overlap, many of the mammals transgress upon the communities of their neighbors. For this reason, and because shrews are mainly carnivorous and consequently less dependent upon the plants than non-carnivorous mammals, shrews utilize a large number of plant and animal associations.

The cinereous shrew has been trapped in association with the collared lemming, singing vole, red-backed vole, Arctic shrew, Arctic ground squirrel and Arctic fox and is closely associated with the brown lemming on the northern part of the Arctic Slope and with the tundra vole on the southern part of the slope. The least weasel is also associated with this shrew.

Most of the ecological information about the shrews of the Arctic Slope has come from records kept of catches in traps.

At Chandler Lake a community typical for this shrew occurred on a gentle slope immediately above the sedges of the marsh and immediately below the meadow of the elevated benchland. Most of the ground was covered with water that had drained down from the benchland above. During periods of runoff of rain, the ridges between old caribou trails stood out as isolated islands supporting grasses. The adjacent hillsides were dry. In our trap-line here the cinereous shrew was caught along with the tundra vole, singing vole, brown lemming and the savanna sparrow (*Passerculus sandwichensis*). Two cinereous shrews were taken on consecutive days in the same trap suggesting a certain degree of intraspecific tolerance in this shrew. In another trap-line on a wet meadow near the dry hillside, we collected four cinereous shrews and two Arctic shrews. In one instance the two species were caught in the same trap on consecutive days. The influence of the dry hillside may have accounted for the presence of Arctic shrews in this marsh.

At Chandler Lake between August 15 and August 19, 1951, we trapped in a steep willow and grass swale bordered by unconsolidated and stabilized rock fields. The upper limit of the drainage was sealed with large boulders. Singing voles occupied the lower limits of the swale and red-backed voles were dominant where large boulders gave overhead protection; cinereous shrews utilized the contact between the areas inhabited by singing voles and red-backed voles. The trap on either side of the one which held a shrew caught red-backed voles. In another line of 100 traps, which was left in the same position for three consecutive nights, two mammals were taken, a brown lemming and a cinereous shrew, both in the same trap but on different nights. In August, 1951, at Chandler Lake, cinereous shrews were taken on the 10th along with Arctic shrews, singing voles and red-backed voles, on the 19th on a damp to wet hillside of marsh grass, and also from natural fissures in the soil paralleling a large stream of water at the south end of the lake. The four cinereous shrews taken from fissures all were in a 100-meter long section of the trap-line, suggesting that they were a family group.

At Chandler Lake on August 23, 1951, one cinereous shrew was taken from a line of traps that yielded also 28 red-backed voles, 5 singing voles and 1 Smith's longspur (*Calcarius pictus*). This trap-line was at the base of a rockslide, which was in a late xeroseral stage. Along the contact between the base of the rockslide and the flat benchland there were willow and birch and more moisture there than elsewhere. There was more activity of mammals in the area of contact than to either side of it where there were, of plants, only mosses, lichens and other dwarfed plants. In the area of contact the cinereous shrew was using runways made and maintained principally by the red-backed vole and secondarily by the singing vole. This community was not optimum for the cinereous shrew. Another cinereous shrew was captured at the entrance of a large burrow on a dry rocky sidehill. Birch and willow were in the immediate vicinity but the area around the hole was bare.

At Kaolak on July 23, 1951, cinereous shrews were found where dry hummocks supporting dwarf willow met low wet meadows supporting sedges and grasses. This zone of contact was bare, damp ground under a sparse overhead protection of grasses and willow, but with no runways. Although associated with a dry plant community these shrews were only two meters from a wet meadow where brown lemmings lived. A cinereous shrew was also taken on July 24, 1951, in a runway in a community of dwarf willow and cotton-grass. This community was damp to wet. Brown lemmings were the principal smaller mammals, although there were a few collared lemmings.

At Porcupine Lake, on July 13, 1952, a cinereous shrew was trapped at the contact between a wet meadow and the dry upland tundra. The meadow had a stream which overflowed at intervals. Our trap-line yielded 6 tundra voles, 3 singing voles, 1 red-backed vole and 2 savanna sparrows. The presence here of singing voles and red-backed voles shows the influence of the drier hillside community; tundra voles typically inhabit wet meadows and are the principal mammals associated with cinereous shrews. Other communities were tested such as dry hillsides supporting dwarf birch (*Betula nana*) and draws supporting high willows and alder, but the marsh area was the only one yielding cinereous shrews.

At Lake Schrader, cinereous shrews were taken only in a low, polygon area. This polygon area was a wet to damp meadow inhabited by brown lemmings, tundra voles and Baird sandpipers.

At Umiat between August 31 and September 3, 1951, we found cinereous shrews in the low marsh areas; they were taken also from small willow-patches on the bare hillsides in association with singing voles, red-backed voles and Arctic shrews.

At Point Barrow on September 9, 1952, a cinereous shrew was obtained ten meters from the bare gravels surrounding the Arctic Research Laboratory. This shrew was in a pure stand of *Arctophila fulva* and was within 200 mm of a well established runway within an area supporting approximately 18 brown lemmings per acre. No other small mammals were present.

As may be noted from the above records, this shrew lives in a variety of communities, but finds the damp to wet communities supporting grasses and sedges to be optimum.

TABLE 2. RELATIVE FREQUENCY OF CAPTURE IN TRAPS OF THREE SPECIES OF SHREWS IN THREE CONSECUTIVE SUMMERS.

Kind	1950	1951	1952
S. a. tundrensis	44%	48%	46%
S. c. ugyunak	44%	50%	38%
S. o. obscurus	12%	02%	16%

The information for 1950 comes from a series of specimens taken by Rausch (1951:165) immediately south of Anaktuvuk Pass in October. The information for the years 1951 and 1952 are our records for the months of July, August and early September. In 1951 we took 56 shrews, whereas in 1952 we took only 13, perhaps as a result of a general decline in shrews on the Arctic Slope. Because most of the information for the years 1951 and 1952 comes from the Brooks Range Province and the Plateau Province, the information may not apply to the low coastal plain.

Eskimos at Barrow Village reported that there are few cinereous shrews in some years and in other years so many as to damage leather and skin equipment in and around Eskimo dwellings, and also that there is an annual movement of shrews in autumn from open tundra into dwellings. In the summer of 1952, between Point Barrow and Barrow Village, we did not obtain the cinereous shrew in 4,800 trap nights. Probably there is a periodic fluctuation of *Sorex*.

We suspect that these shrews wander considerably; our records, however, show many instances where pairs, or as many as four individuals, were taken in the same area or consecutively in the same trap far away from any other such productive areas. Each adult pair of this shrew may have its own territory.

In a series of 12 males taken at Chandler Lake and Umiat there was a decided decrease in length of the testes from 4.5 mm on August 10 to 1.0 mm on August 23. By September 3, the testes of almost every male were approximately 1.0 mm long. We obtained no males in early summer but suspect that there is only one main breeding season and that it is summer. Of 39 specimens taken from July 13 to September 9 inclusive, 17 were females and 12 were males. No embryos were found.

Records of occurrence.—Specimens examined, 42: Nos. 43166, 43170-43175, 43177-43196, 43224, 50404-50408, No. 43176 skull only; Colorado Mus. Nat. Hist., 2014, 4072-4075; Acad. Nat. Sci. Phila. (3 specimens, Nos. 7172 and 159 of McIlhenny). These are distributed by localities as follows: (1) Point Barrow, 156°40′40″, 71°19′30″, 8 ft., 8 (4 Colo. Mus. Nat. Hist.; 3 Acad. Nat. Sci. Phila.) (see also W. Stone, 1900:43; Jackson, 1928:46; Dufresne, 146:159); (2) 7¾ mi. S and 11 mi. W Point Barrow, 156°47′00″, 71°17′

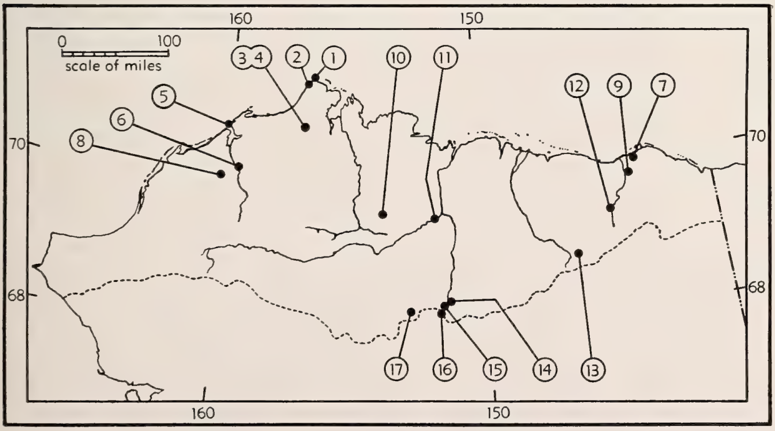


FIG. 3. Record stations of occurrence for *Sorex cinereus ugyunak*. Localities on the distribution maps are numbered from north to south.

22″, 20 ft., 1; (4) 50½ mi. S and 9 mi. W Point Barrow, 156°30′53″, 70°39′30″, 40 ft., 1; (5) Wainright [=Wainwright], 1 (Colo. Mus. Nat. Hist.) (see also Jackson, 1928:56; Bailey and Hendee, 1926:13); (8) Kaolak, 160°14′51″, 69°56′00″, 178 ft., 2; (11) 1½ mi. W and ¾ mi. N Umiat, 152°08′10″, 69°22′18″, 370 ft., 13 (see also Rausch, 1950c:465; 1951:164; 1953:94); (12) Lake Schrader, 145°09′50″, 69°24′28″, 2900 ft., Brooks Range, 1; (13) Porcupine Lake, 146°29′50″, 68°51′57″, 3140 ft., Brooks Range, 1; (17) Chandler Lake, 152°45′, 68°12′, 2900 ft., 13.

Additional records: (3) Meade River (Murdock *in* Ray, 1885:102; Nelson and True *in* Nelson, 1887:271); (6) About fifty miles inland from Wainwright (Bailey and Hendee, 1926:13); (7) Okpilak River near Barter Island (Anderson, 1947:15); (9) Hulahula River, at northern foothills of Brooks Range (Anderson and Rand, 1945:64; Jackson, 1928:46; Rausch, 1953:94); (10) [Arctic Slope, definite locality unspecified] (Turner, 1886:205; Burt and Grossenheider, 1952:5); (14) Kanayut Lake, Brooks Range (Rausch, 1951:165); (15) Tulugak Lake, Brooks Range (Rausch, 1950c:465; 1951:164); (16) Anaktuvuk Pass, Brooks Range (Rausch, 1951:165; 1953:94).

Sorex arcticus tundrensis Merriam
Arctic Shrew (Ugrugnak)

Sorex tundrensis Merriam, Proc. Washington Acad. Sci., 2:16, March 14, 1900, type from St. Michael, Alaska. (Also Hall, 1929:419; Rausch, 1951:165.)

Description.—See colored frontispiece. Average and extreme measurements of 10 males and 8 females from within a radius of 1½ miles of Umiat, mostly (see remarks) showing slight wear on teeth, are, respectively, as follows: Total length, ♂ 97 (91-101), ♀ 100 (94-110); tail, 32 (29-34), 32 (31-34); hind foot, 13 (13-14), 13 (13-14); weight, 7.1 (6.0-9.0), 7.3 (6.0-11.0, all non-pregnant) grams; condylobasal length of skull, 17.7 (17.3-18.0), 17.7 (17.4-18.0); maxillary breadth, 4.9 (4.8-5.3), 5.1 (5.0-5.2). In summer pelage, back Sepia (adults) to near (*l*) Saccardo's Umber (subadults); sides Drab to Pale Drab Gray; underparts Pale Drab Gray; tail between Snuff Brown and Saccardo's Umber (but Light Buff in certain adults) above and near (16′) Light Buff below almost to tip where nearly like back. Winter pelage not seen by us. Snout long and sharp-pointed; eyes minute; 5 toes, each with a claw, on each foot; skull lacking zygomatic arches; 32 teeth; third unicuspid tooth not smaller than fourth (see drawing of skull).

Differs from S. *c. ugyunak* in larger average size of external parts; condylobasal length of skull more than 16.7 mm; maxillary breadth more than 4.5 mm, postmandibular canal present; unicuspid teeth, especially the first, without indentation on anteromedial part of crown; weight of males and non-pregnant females more than 5.5 gms. Differs from S. *o. obscurus* in shorter tail; body saddle-backed (back conspicuously darker than sides instead of same color); third unicuspid tooth always as large as, or larger than, fourth unicuspid instead of smaller than fourth.

Remarks.—S. *tundrensis* has been described (Jackson, 1928:72) as differing from S. *arcticus* in the following respects: tail shorter; color paler and more distinctly tricolored in pattern; skull a trifle smaller, rostrum smaller and lower, mesopterygoid space shorter, postglenoid processes and teeth smaller; palate shorter.

The palatal length and the length of the maxillary tooth-row in our specimens average 6.4 and 7.2, respectively. In a series previously (Hall, 1929:420) reported on from Point Barrow these measurements were 6.5 and 7.3. These two measurements seem to be only slightly (one-tenth of a millimeter on the average) smaller than in S. *arcticus* to the southeast although Jackson (*loc. cit.*) thought that S. *tundrensis* was considerably smaller in these measurements. Of S. *tundrensis,* Jackson had no specimens from so far north as ours, which seem to average larger than those from farther south in Alaska. Consequently, S. *tundrensis* and S. *arcticus arcticus* differ less than was previously supposed. We find that the

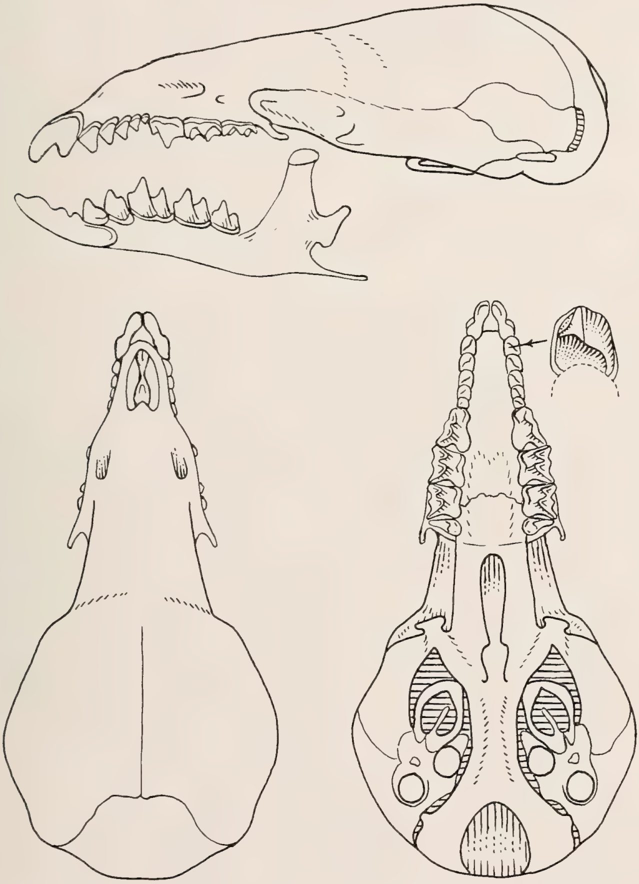


FIG. 4. Skull of *Sorex arcticus tundrensis,* 1½ mi. W and ¾ mi. N Umiat, 152°08′10″, 69°22′18″, 370 ft., September 3, 1951, No. 43212 KU, ♂. × 4.

mesopterygoid space is as long in some specimens of *tundrensis* (for example, KU No. 50415 from Umiat) as in some specimens of *arcticus* (for example, MCZ No. 18759 from 9 mi. N Jack Fish Lake, Athabasca Delta). Furthermore the smaller and lower rostrum of *tundrensis* is not apparent, taking over-all size into account. The circumstance that the subspecies S. *cinereus ugyunak* of the Arctic differs from the subspecies S. *cinereus cinereus* of more southern distribution in much the same fashion—shorter tail, paler sides and slightly smaller skull—that S. *tundrensis* differs from S. *arcticus arcticus* is further indication that *Sorex tundrensis* Merriam is only subspecifically different from the earlier named *Sorex arcticus* Kerr. Consequently we employ the name-combination *Sorex arcticus tundrensis.*

The Arctic shrew is found throughout the Arctic Slope and especially in the Brooks Range and along the major river valleys of the Plateau Province.

Because of its carnivorous habits, the Arctic shrew, like both the other two species of shrew that inhabit the Arctic Slope, has the capacity to adjust to a wide range of physiographic types. It is most common on hillsides and when in the flat valleys is associated with ridges or relief and is less aquatic than the other two shrews. Nevertheless it uses runways in which there is some water. It is active in sub-freezing weather, in rainy weather and at some times when the wind blows strongly enough to increase the cooling effect of the general atmosphere; we suspect that on such days the duration of activity is limited. The Arctic shrew when captured in live-traps does not die from exposure so quickly as the cinereous shrew. At death both species usually curl up on the backbone, not on the side. The Arctic shrew, as well as each of the other two species of shrew, is active at any time in the 24 hour period during summer.

Plant communities in which the Arctic shrew lives are drier than those supporting the cinereous shrew and lack high overhead protection usually required by the dusky shrew.

The animal community governs the distribution of this species. On the southern part of the Arctic Slope, this shrew is associated principally with the red-backed vole and to a lesser extent with the singing vole. On the northern part of the Slope, on the Coastal Plain, this shrew is associated more often with the collared lemming than with the brown lemming.

Between August 30 and September 4, 1951, in the Colville River Valley and on its sloping sides, at Umiat, we found the Arctic shrew associated with plant communities ranging from flat tundra beyond the eroded river valley to flat wet meadows of the valley floor proper. Immediately below the brink of the side of the valley, at about the snow-cornice line, this shrew was taken at the edge of high dense stands of willow and alder, but rarely within the dense cover of the trees themselves. On the sides of the valley, low dense vegetation consisting of dwarf birch (*Betula nana*), *Ledum, Salix, Alnus, Empetrum nigrum, Arctogrostis, Vaccinium* and Arctic tea seemed to be preferred. A typical catch from a trap-line in a community of the above type was 1 Arctic shrew, 2 brown lemmings, 10 singing voles, 6 red-backed voles and one red-spotted bluethroat (*Luscinia svecica*). It will be noted that the tundra vole was not listed in this community; that species lives on the floor of the valley. The riparian community of alder and willow which grew in dense stands, did not seem to be used except at the line of contact between the trees of the moister soil and the shrubs of the drier slopes. One preferred community in the valley was on the brink of old erosional benchlands. These are generally about 10 feet high and support a dense matlike growth of dwarf birch, a few dwarf willow, Arctic tea and *Vaccinium* bordered by *Eriophorum* on the benchland and grasses and sedges on the low downhill slope. These conditions remind one of the krummholtz association at timberline in more southern latitudes, where there is almost complete overhead protection and bare soils beneath. Wet, hillside meadows having running water support only an occasional Arctic shrew. Well-drained ridges of polygons and especially the stabilized dry mounds of matlike dwarf birch and dwarf willow have a higher percentage of Arctic shrews than do any of the previously mentioned plant associations. Under dwarf birch and dwarf willow the ground is relatively bare and mounds are surrounded by wet or damp marshes or by meadow vegetation. Polygon ridges support grasses and sedges and have a greater percentage of cinereous shrews whereas dry mounds have a greater percentage of Arctic shrews, although the two communities frequently adjoin one another.

On August 23, 1952, at Gavia Lake where the topography is characterized by low relief resembling that of the Coastal Plain, an Arctic shrew was trapped along the erosional banks of the ox-bows, where willow and alder formed a shrublike overhead protection about 6 feet high. From one line of 52 traps, placed along one of these erosional banks, we collected 1 Arctic shrew, 21 tundra voles (confined to the grasses and sedges at the base of the bank), 8 singing voles, 2 red-backed voles, 2 Arctic ground squirrels, 3 savanna sparrows, 1 red-spotted bluethroat and 1 Alaskan longspur.

At Umiat on September 4 we observed an active male Arctic shrew at twilight. It ran 2 meters along a trail relatively slowly but at a constant speed. The shrew went up and down grades at the same speed in contrast to the faster but irregular movement of microtines. The trail over the mosses and lichens was distinct and uniform throughout its length. The floor of the sunken trail was flat and the sides were vertical. In part of the trail there was water which the shrew navigated without deviation of course or speed. Traps were set in this trail for two days and the only mammals taken were one male shrew on the 4th and a female on the 5th. Both of these shrews were traveling in the same direction. Another male and female were taken from a sunken trail over sphagnum moss. It seems that some Arctic shrews do have established trails and use them consistently.

Our trapping records indicate that each of the species of shrew is better adapted to live in some communities than in others. Indeed, for each species there is a particular niche having conditions optimum for the species but there is some overlap in species because each sometimes occurs in an association that is not optimum for it. In each of 13 different communities the order of abundance of the kinds of shrews as indicated by relative frequency of capture was as given in the paragraph immediately following. The species of shrew listed first was captured most often and the one listed last was captured least often.

High overhead protection of *Alnus* and *Salix* with relatively bare ground beneath, (1) *obscurus*, (2) *tundrensis*, (3) *cinereus;* low overhead protection of *Betula nana* and dwarf *Salix* with relatively bare ground beneath, (1) *tundrensis*, (2) *cinereus*, (3) *obscurus;* matted grass or short grass dense to base, (1) *cinereus*, (2) *tundrensis*, (3) *obscurus*; dry community, (1) *tundrensis*, (2) *obscurus*, (3) *cinereus;* along streams with typical riparian shrublike to arborescent type of vegetation, (1) *obscurus*, (2) *cinereus*, (3) *tundrensis*; on extensive areas of mosses and lichens, (1) *tundrensis*, (2) *obscurus*, (3) *cinereus;* in trails made by small mammals, (1) *cinereus*, (2) *tundrensis*, (3) *obscurus*; in association with *Clethrionomys*, (1) *tundrensis*, (2) *cinereus*, (3) *obscurus*; in association with *M. miurus*, (1) *tundrensis*, (2) *cinereus*, (3) *obscurus;* in association with *Lemmus* and *M. oeconomus*, (1) *cinereus*, (2) *tundrensis*, (3) *obscurus;* in association with *Dicrostonyx*, (1) *tundrensis*, (2) *cinereus*, (3) *obscurus*; greatest latitude of habitat preference, (1) *cinereus*, (2) *tundrensis*, (3) *obscurus;* in association with the largest populations of animals, (1) *cinereus*, (2) *tundrensis*, (3) *obscurus*.

The late Charles D. Brower reported to Hall that there were great numbers of *S. a. tundrensis* at Barrow Village in the autumn of 1927. Specimens were saved at that time (see Hall, 1929:419).

Territoriality in *tundrensis* is inferred from our observations on the limited extension of their trails and on the frequency of capture of both a male and a female in the same trap within one system of trails made by this species. Most of the Arctic shrews that we obtained were trapped in trails used by other mammals or in areas not supporting trails.

Testes decreased abruptly in size at the onset of autumn; length of testes was 7 (6-8) mm between July 27 and August 23 in males ranging from 94 mm to 112 mm in total length, and was only 1 to 2 mm in specimens taken between August 31 and September 3—specimens measuring 91 to 100 mm in total length.

No pregnant females were taken between July 25 and September 3. One female, taken on September 4, held 10 embryos measuring 14 mm in length.

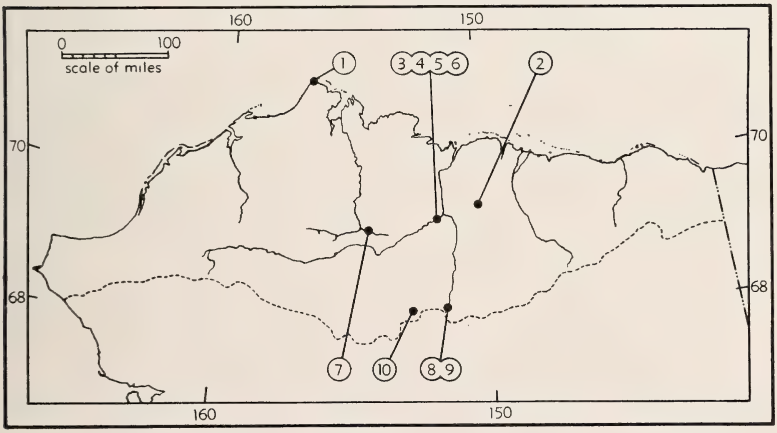


FIG. 5. Record stations of occurrence for *Sorex arcticus tundrensis.*

Records of occurrence.—Specimens examined, 31:Nos. 43199-43223, 50411-50416. No. 43202 skull only. These are distributed by localities as follows: (2)Gavia Lake, N White Hills, 150°00′, 69°35′, 460 ft., 2; (3) $1\frac{3}{10}$ mi. E and $1\frac{3}{10}$ mi. N Umiat, 152°05′30″, 69°23′12″, 350 ft., 1; (4) $\frac{9}{10}$ mi. W and $\frac{9}{10}$ mi. N Umiat, 152°10′58″, 69°22′53″, 380 ft., 2; (5) 1½ mi. W and ¾ mi. N Umiat, 152°08′10″, 69°22′18″, 370 ft., 20; (6) Umiat, 152° 09′30″, 69°22′08″, 352 ft., 1; (10) Chandler Lake, 152°45′, 68°12′, 2900 ft., 6.

Additional records: (1) Barrow (Hall, 1929:420); (7) [Arctic Slope, definite locality not specified] (Burt and Grossenheider, 1952:12); (8) Itikmalukup Creek (Rausch, 1951:165); (9) Tulugak Lake (Rausch, 1951:165).

Sorex obscurus obscurus Merriam
Dusky Shrew (Ugrugnak)

Sorex obscurus Merriam, N. Amer. Fauna, 10:72, December 31, 1895. New name for *Sorex vagrans similis* Merriam, N. Amer. Fauna, 5:34, July 31, 1891, type for Timber Creek, Lemhi Mountains [="Salmon River Mountains"], 10 mi. W Junction, 8200 ft., Lemhi County, Idaho.

Sorex obscurus obscurus, Rausch, Jour. Mamm., 31:465, November 21, 1950. (Also Rausch, 1951:164; 1953:93.)

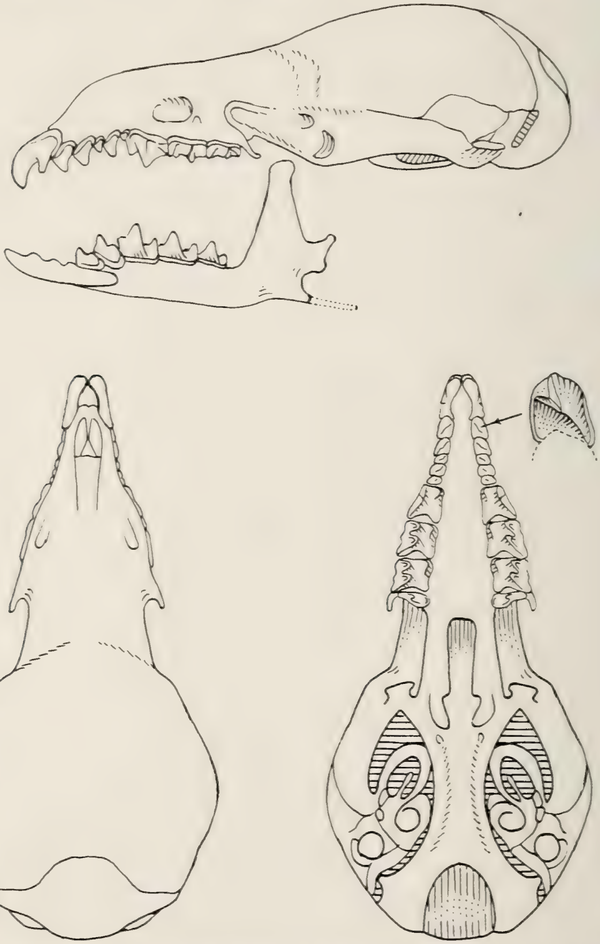


FIG. 6. Skull of *Sorex obscurus obscurus*, Chandler Lake, 152°45′, 68°12′, 2900 ft., August 10, 1951, No. 43197 KU, ♀. × 4.

Description.—See colored frontispiece. Measurements of 2 males from Wahoo Lake and 1 female from Chandler Lake, showing slight to moderate wear on teeth, are, respectively, as follows: Total length, ♂ 112, ♂ 113, ♀ 116; tail, 42, 45, 47; hind foot, 13.0, 14.0, 14.5; condylobasal length of skull, 17.6, ———, 16.9; maxillary breadth, 5.1, ———, ———; weight, 8.0, 8.0, 5.5 grams. In summer pelage, back near (*j*) Olive-Brown; sides like back; underparts Pale Drab Gray; tail Chaetura Drab and Hair Brown above, Pinkish Buff and near (*g*) Pale Olive Buff below. Winter pelage said to be distinctly more grayish. Snout long and sharp-pointed; eyes minute; 5 toes, each with a claw, on each foot; skull lacking zygomatic arches; 32 teeth; third unicuspid tooth smaller than fourth (see drawing of skull).

Differs from S. *c. ugyunak* in larger size; no overlap in any measurements of our specimens; sides colored like back instead of ordinarily lighter than back; third unicuspid tooth smaller than fourth unicuspid instead of as large as, or larger than, fourth. Differs from S. *a. tundrensis* in longer tail; sides colored like back instead of conspicuously lighter than back; third unicuspid tooth smaller than fourth unicuspid instead of as large as, or larger than, fourth.

Remarks.—Our three specimens from the north slope of the Brooks Range are paler (more grayish) than specimens from south of the Brooks Range. The large size of our specimens (total length of 112, 113, 116 and condylobasal length of........, 17.6, 16.9) is near the maximum for the subspecies S. *o. obscurus* and may reflect a larger size in the northern populations of this subspecies than in the southern populations. Although S. *o. shumagensis* to the west is said to have a tendency to a tricolor pattern, there is no such tendency in our three specimens.

The dusky shrew is found throughout the Brooks Range and out onto the Plateau Province wherever favorable habitats exist. Probably it will occasionally be found on the Coastal Plain in areas supporting adequate overhead protection in the form of willows and alders, particularly along major stream courses. Rausch (1951:164) found it to be the most common shrew in the Anaktuvuk Pass area. At Chandler Lake and Porcupine Lake we found this shrew to be the least common of the three shrews that inhabit the Arctic Slope.

The dusky shrew has been taken from both level valleys and steep hillsides. In any physiographic situation this shrew usually is dependent upon running water and overhead protection and was more common along deep stream channels than elsewhere. Of the three species of *Sorex,* the dusky shrew requires the most protection from the elements; it gains this protection usually by inhabiting the stream-edge of the flood-plain above the stream where both the vegetation and the shrew benefit from the moderating influence of running water.

The dusky shrew is adapted to riparian and spring communities of high overhead protection supplied by larger arborescent shrubs (willow and alder) and a relatively sparse ground vegetation of

Equisetum, mosses, lichens and grasses. Rausch (1951:164) trapped this shrew in the mosses, *Philonotis fontana* and *Pholia wahlenbergii*, around springs.

The most common small mammals associated with the dusky shrew are the red-backed vole and singing vole.

Two dusky shrews collected at the west end of Wahoo Lake on July 4, 1952, from a typical community, were taken from a deeply cut creek channel lined with willows some of which measured 10 feet high and four inches in diameter at the base. The floor along the edge of the creek was relatively open with but few fallen dead limbs, mosses and small herbs. Large accumulations of droppings of ptarmigan found along the creek suggested that this community offered protection from winds and cold in winter. Shrews as well as ptarmigan may have availed themselves of this protection. In this community there is not much competition with other mammals. For instance, in the three nights of trapping (225 trap-nights with a .02% yield) from a stationary line, 2 dusky shrews, 1 red-backed vole and 3 singing voles were taken. On the third night no mammals were taken from the trap-line. In other trap-lines along the edge of Wahoo Lake and in the open swales leading from the lake the catch ranged from 21 to 25 per cent. A wandering tattler and an American robin were nesting within 10 meters of where a dusky shrew was taken. The Arctic ground squirrel and the ptarmigan also were observed at almost the exact place where the shrews were taken. Daily extremes in temperatures during the period of trapping were 36° F. min. and 70° F. max. In an effort to test the altitudinal distribution of *Sorex* at Chandler Lake, between August 16 and 19, 1951, a line of traps was set from the base of a mountain, where it met the valley floor, to a position high on the slope. This trap-line followed an intermittent spring-fed stream bordered in places by dwarf willows and grasses and elsewhere by stabilized rockslides and boulder fields, especially in the upper part where the stream ran beneath the rock field. The yield (see fig. 7) from the trap-line revealed the preference of red-backed vole for the pro-

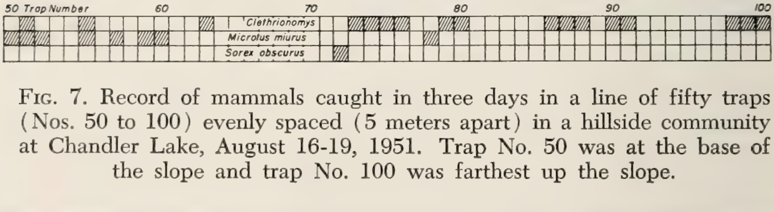


FIG. 7. Record of mammals caught in three days in a line of fifty traps (Nos. 50 to 100) evenly spaced (5 meters apart) in a hillside community at Chandler Lake, August 16-19, 1951. Trap No. 50 was at the base of the slope and trap No. 100 was farthest up the slope.

tection afforded by rock-fields, and the preference of singing voles for running water and willows. It will be noted that the dusky shrew is associated with red-backed voles where there is overhead protection. In no instance were a shrew and red-backed vole taken in the same trap.

The only evidence of territoriality is from trapping two dusky shrews from a creek channel connecting Wahoo Lake and the Ivashak River. The nature of this stream course and associated vegetation would limit the shrew to approximately 50 linear meters of this riparian community. Because no other *Sorex* was taken, there is the suggestion that the two individuals controlled this isolated community.

Rausch (1951:164) recorded embryos in dusky shrews on June 1 and July 26 of 1949 from Anaktuvuk Pass. Tracks were also seen in winter.

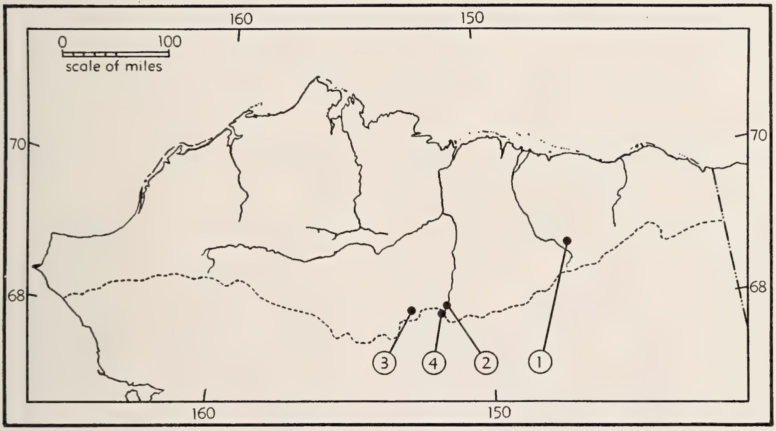


Fig. 8. Record stations of occurrence for *Sorex obscurus obscurus.*

Records of occurrence.—Specimens examined, 3: Nos. 43197, 50409, 50410. These are distributed by localities as follows: (1) Wahoo Lake, 146°58′, 69°08′, 2350 ft., Brooks Range, 2; (3) Chandler Lake, 152°45′, 68°12′, 2900 ft., 1.

Additional records: (2) Tolugak [Tulugak]Lake (Rausch, 1950c:465;1951:164); (4) Anaktuvuk River (Rausch, 1953:93).

Lepus othus othus Merriam
Tundra Hare (Ukalisukruk)

Lepus othus Merriam, Proc. Washington Acad. Sci., 2:28, March 14, 1900, type from Saint Michael, Norton Sound, Alaska. (Also Nelson, 1909:69.)

Lepus othus othus, Howell, Jour. Mamm., 17:332, November 16, 1936. (Also Rausch, 1951:178.) Inferentially Ellerman and Morrison-Scott (1951:438) regard *L. othus* as conspecific with *Lepus timidus* when they write of the latter "Probably also in North America".

Lepus timidus, True, Proc. U. S. Nat. Mus., 7 (App., Cir., 29):601, November 29, 1884.

Lepus timidus arcticus, Murdock, *in* Expedition to Point Barrow, Alaska, Exec. Doc. No. 44 (48th Congress, 2nd Session), p. 103, 1885. (Also Nelson and True *in* Nelson, 1887:233,271.)

Lepus tschuktschorum, W. Stone, Proc. Acad. Nat. Sci. Philadelphia, Pt. 1, p. 35, 1900.

Lepus tschukschorum, Elliot, Field Columbian Mus., zool. ser., p. 271, 1901.

Lepus timidus othus, Rausch, Arctic, 6 (2):116, prior to October 2, 1953.

Description.—A large hare, brownish in summer and white in winter but with tips of ears always blackish. Measurements of a male from Ikpikpun River (after W. Stone, 1900:35) are: Total length, 725; tail, 117; hind foot, 190; ear, 108; total length of skull, 112; greatest breadth, 57; greatest breadth of nasals, 24; 28 teeth; details of skull as shown in fig. 9. Can be confused with the snowshoe hare; for differences between the two species see key on page 263.

Reasons for using the current name *Lepus othus othus* instead of *Lepus timidus othus* (which latter may well be correct) are on pages 61 and 62 in the discussion of *D. groenlandicus rubricatus, versus D. torquatus rubricatus.*

Murdock (1885:103) says that "There were absolutely none near the station [Point Barrow], and the natives were unacquainted with the animals. Capt. E. P. Herendeen, however, reports seeing traces of hares among the willow on the Meade River [he did not go farther than 70° to the south] in March, 1882 .... [But] in August, 1883, a party of Nunatangmeun Eskimos brought in half a dozen roughly-prepared skins of this species, showing the occurrence of the animals somewhere in the Colville region."

Howell (1936:334) quotes part of a letter written by Mr. Charles D. Brower and sent to Dr. E. W. Nelson. "Regarding the Arctic hares this far north I would say that in all my experience I have never known them to live on the low tundra anywhere near the coast. In 1884-85, when I wintered at Corwin coal mine, they were fairly abundant in that region and a few were taken inland from Point Lay. During the winter of 1897 I had a hare brought me from inland on the Chipp River. I gave the whole animal to E. A. McIlhenny, who sent it out with his collection. Several times I have had these large hare skins brought in to Barrow by natives wintering up the Colville River, so I take it they must be fairly numerous inland where the ground is high."

Rausch (1951:178) says that the Nunamiut Eskimos had seen the Arctic hare near Umiat on the Colville River.

Harmon Helmericks, on August 25, 1946, found a foot of a rabbit which he identified as the tundra hare from near the mouth of the Kuparuk River. He told us that Paneak says that tundra hares were common in the general area of the mouth of the Anaktuvuk River in 1925.

Charles Hummel, United States Geological Survey, who was a member of a party that surveyed 1000 square miles at the headwaters of the Colville River in the Plateau Province and Brooks Range in June and July of 1950, saw only two rabbits. They were large and probably were tundra hares. On August 20, 1949, at 154°10′, 68°23′, along the Killik River, near the mouth of the Killik River Canyon which adjoins the open Plateau Province and therefore is far from any coniferous plant-cover such as is favored by the snowshoe

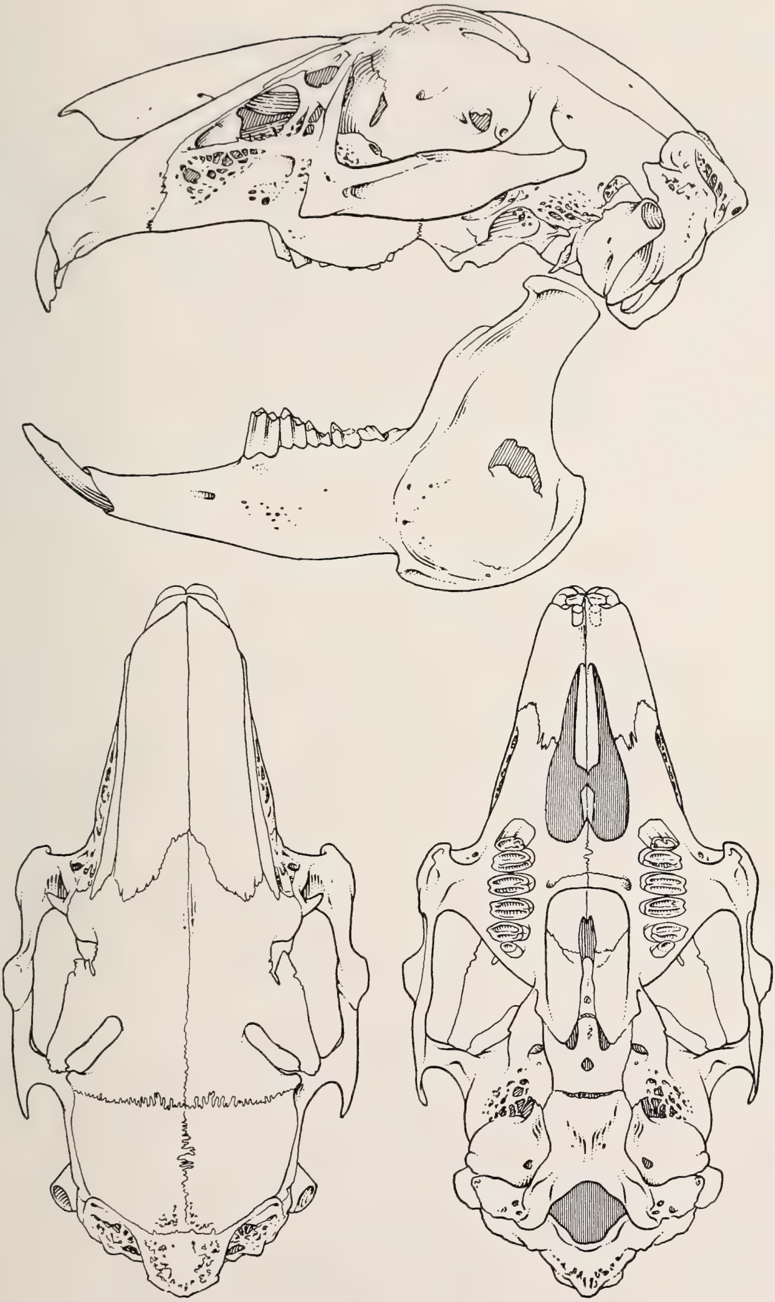


Fig. 9. Skull of *Lepus othus othus,* Teller, Alaska, August 3, 1913, No. 3194 Carnegie Museum, ♀. × ⅞.

rabbit, Marvin Mangus saw a large rabbit, which he thought was a tundra hare.

Records of occurrence (no specimens examined).—(1)"on the Meade River [not farther than 70° to the south]" (Murdock *in* Ray, 1885:103, seen by Capt. E. P. Herendeen in March , 1882; "Point Barrow" [probably the Meade River record of Murdock], Nelson and True *in* Nelson, 1887:233); (2) Ikpikpun River (W. Stone, 1900:35, "one skeleton of a male obtained April, 1898"); (3) "east of Point Barrow . . . back from the coast" (Howell, 1936:334); (4) Kuparuk River, 149°02′00″, 70°16′30″ (foot picked up by Harmon Helmericks on August 25, 1946—*fide* J. W. Bee, MS, 8 September 1952); (5) ". . . somewhere in the Colville region" (Murdock, 1885:103); (6) [definite localities unspecified] North America . . . northwestwards to the Arctic Coast (True, 1884:601); [Cape Thompson] north along the Arctic Coast [to near] the vicinity of Point Barrow (Nelson and True *in* Nelson, 1887:271); northwest Alaska from [Cape Thompson] to Arctic Ocean (Elliot, 1901:271); western Alaska (Trouessart, 1904-5:540); "tundras of northern and northwestern Alaska" (Nelson, 1909:60, 69; Miller, 1924:450); [Arctic Slope] (Burt and Grossenheider, 1952:144); (7) east of the upper Colville River and possibly farther (Howell, 1936:319, 333); (8) inland from Point Lay (Howell, 1936:334); (9) mouth Anaktuvuk River, 151°30′, 69°30′ (Rausch, 1951:178; seen also by Paneak in 1925 and reported by Harmon Helmericks—*fide* J. W. Bee, MS 8 September 1952); (10) . . . near Umiat on the Colville River (Rausch, 1951:178); (11) Corwin coal mine (Howell, 1936:334); (12) "along the coast as far north as Cape Lisburne" (Howell, 1936:334); (13) head Colville River [where at the head of the river unspecified] (two seen by Charles Hummel in June and July, 1950—*fide* J. W. Bee, MS, 11 June 1952); (14) Killik River, 154°10′, 68°23′ (seen by Marvin Mangus on August 20, 1949).

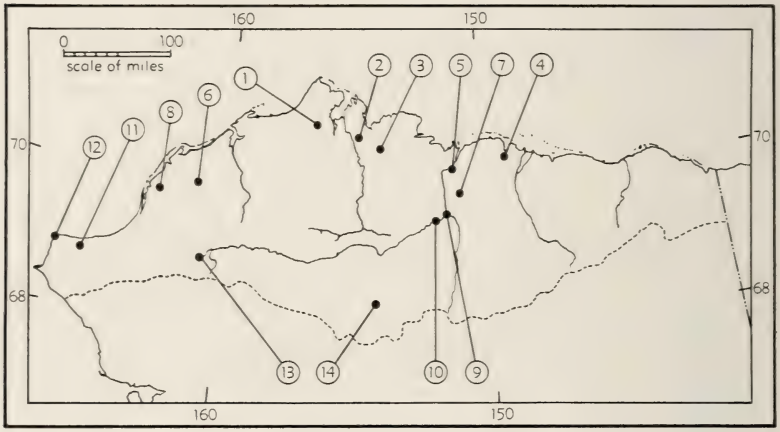


FIG. 10. Record stations of occurrence for *Lepus othus othus.*

A skeleton of the tundra hare, reported by W. Stone (1900:35) under the name *Lepus tschuktschorum* (Nordquist), was obtained in April of 1898 on the Ikpikpun River. This catalogued specimen has been lost or misplaced. All other records of the tundra hare are of animals not preserved for scientific study.

Marmota caligata broweri Hall and Gilmore
Hoary Marmot (Sikrikpak)

Marmota caligata broweri Hall and Gilmore, Canadian Field-Nat., 48:57, April, 1934, type from Point Lay [probably inland at higher elevation on W end of Brooks Range], Arctic Coast of Alaska. (Also Rausch, 1950c:466; 1951:178.)

Marmota caligata, Anderson, *in* My Life with the Eskimo by V. Stefansson, 1913b:510.

Marmota caligata caligata, Bailey and Hendee, Jour. Mamm., 7:20, February 15, 1926. (Also Hall, 1929:422; Anderson, 1937:109; Dufresne, 1946:133.)

Marmota marmota broweri, Rausch, Arctic, 6:116, prior to October 2, 1953 (see comments under "*Remarks*" below).

Description.—A large (2 feet long), short-tailed (6 inches long), squirrellike rodent predominantly black and white with some reddish.

Measurements of a male and a female from Lake Peters and a female from Chandler Lake, all adults, are, respectively, as follows: Total length, 580, 600, 553; tail, 152, 162, 150; hind foot, 87, 86, 88; ear from notch, 25, 23, 25; weight in grams, 3629, 3629, 3181; condylobasal length, 85.4, 87.0, ———; palatal length, 49.6, 50.7, ———; postpalatal length, 32.3, 32.5, 30.6; greatest length of nasals, 34.9, 35.7, 34.9; zygomatic breadth, 56.2, 56.4, 55.8; breadth across mastoids, 38.0, 37.9, 38.1; least interorbital breadth, 21.5, 23.2, 20.9; breadth of rostrum, 18.8, 18.9, 18.1; maxillary tooth-row, 21.1, 20.2, 21.9. Fresh pelage (August 25, Chandler Lake): Upper parts blackish with white tips of underfur and white subterminal bands of guard hairs showing through the black-tipped or dark brown-tipped guard hairs; underfur at base near (*n*) Chaetura Black (shading on hinder back to Fuscous-Black); head black; underparts blackish with some white-tipped hairs; hair of tail with cinnamon band 12 mm wide above the basal black band and below a subapical black band and the white apical tip. Body thickest; head short and broad; legs short; tail densely haired and slightly flattened; thumb of forefoot with broad flat nail (not a claw); 5 pairs of mammae (2 pectoral, 2 abdominal, 1 inguinal).

Remarks.—The close resemblance of North American and Eurasian marmots that have borne the names *Marmota caligata* and *Marmota marmota,* among others, has led Rausch (1953:116) to use the name-combination *Marmota marmota broweri* for the animal here concerned. This combination of names may be correct but for the reasons given under the account of *Dicrostonyx groenlandicus rubricatus,* we at this time are reluctant to adopt the combination.

The records of occurrence for this subspecies at Point Lay and Cape Thompson (Hall and Gilmore, 1934:58; Rausch, 1951:178) should not be interpreted literally inasmuch as later information indicates that the Eskimos at these places, who provided the specimens, probably captured the animals some miles distant.

The two adults from Lake Peters, taken on August 4 and 5, 1952, have much cinnamon color on the hinder back where the older pelage seems still to be in place as it is also on the tail (only distal fourth in the male). The only noteworthy difference from the holotype of *M. c. broweri,* to judge from the original description, are black instead of white feet in most of our specimens, less cinnamon color, more concave inferior margin of mandible and in some specimens a greater projection posteriorly of the angular process of the mandible in relation to the articular process.

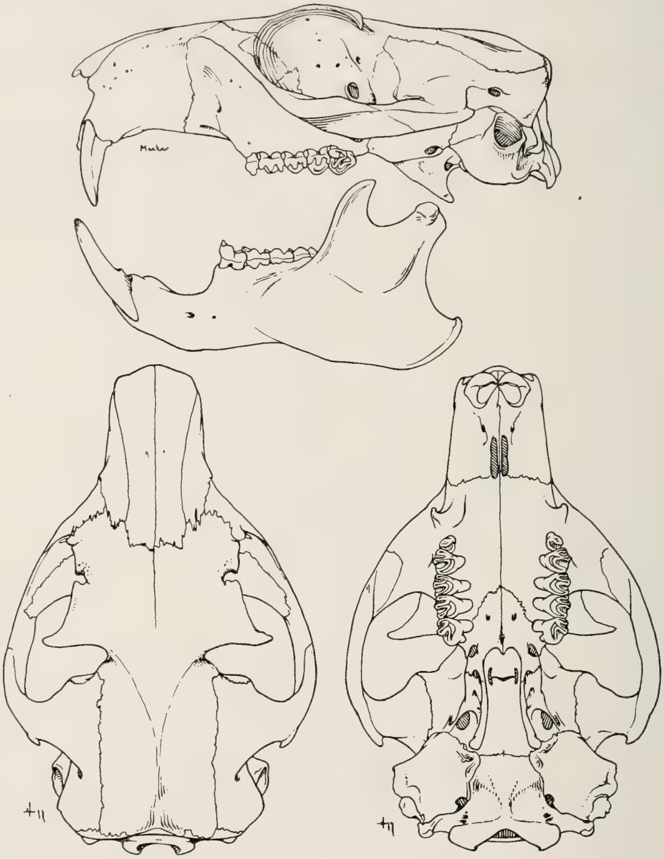


FIG. 11. Skull of *Marmota caligata broweri,* mouth Chamberlin Canyon, S end Lake Peters, 145°08′34″, 69°20′58″, 3690 ft., Brooks Range, August 4, 1952, No. 50417 KU, ♀. × ¾.

The hoary marmot occurs throughout the Brooks Range and is present also in the Plateau Province in boulder fields and talus. If such habitat occurred at sea level the marmot probably also would be there. Other subspecies of this same species occur only a few feet above sea level in southern Alaska. In mountains this species seems to be of local occurrence and to live in loose communities. On two trips in search of marmot—one of 10 hours up a side canyon to the west of the south end of Chandler Lake, and another of eight miles to the south of Lake Peters by one of us (Bee)—no marmot was seen or heard although the entire area investigated seemed to be ideal for the species. In other areas such as the mountain slopes surrounding Lake Peters the marmot was common and lived in loose communities. In canyons so far from Lake Peters that the temperature was but little influenced by that body of water, marmots were less common or absent.

The precipitous sides of canyons and valleys in the Brooks Range are preferred habitat of the marmot. It commonly lives and rears its young at the base of active talus where boulders are large and have accumulated to a depth sufficient to give subsurface protection. Shallow accumulations of boulders or slides of any depth, which have been completely sealed in with vegetation, are uncommonly used. Nevertheless stabilized rock fields and lateral moraines on mountain slopes, which are in the later seral stages of succession, are inhabited. The older lateral terminal moraines, when present, are commonly inhabited.

At Lake Peters the marmot inhabits the high steep walls of the canyon. The elevation of Lake Peters is 2900 feet and the top of nearby Mount Chamberlin is 9,000. We found the marmot inhabiting only that section of the mountain side between 3250 and 4000 feet. The first 350 feet above the level of the lake and the highest 5,000 feet yielded no sign of marmot although it was sought. The average elevation of the 11 places where the marmot was observed at Lake Peters was 3,700 feet, or 800 feet above the lake. Clearly the marmot here lived at a relatively low elevation in relation to the elevations that were available but did live well above the floor of the canyon.

Dr. William Steere found the marmot inhabiting an isolated, combed, conglomerate ridge on the Kuparuk River.

This marmot is equipped to withstand the climate of the spring, summer, and fall, but not the deep snow and prolonged cold of winter; in that season the marmot retires to an underground den for an extended period of hibernation. An element of the climate that is important to the marmot is the wind because it controls certain insects that annoy the animal.

Wherever the marmot was observed it was associated with most of the common herbaceous and annual plants. The ermine, more often than any other mammal, lived in the same rock pile with the marmot; tracks showed that the wolverine walked along the edges of the rock piles; the red-backed vole lived in the foraging area of the marmot, and to a certain extent in the rock pile; the caribou and Dall sheep grazed over and walked through the foraging area of the marmot; from the frequency with which the golden eagle inspects areas inhabited by the marmot and from the response of the marmot, it is inferred that the eagle is an important, and perhaps the most important, enemy.

At the edges of some smaller rock fields in which marmots lived, vegetation was appreciably grazed.

The color of the dark pelage blends almost perfectly with that of the dark lichens of the rock field. Even so this species, in my (Bee) experience is more wary than either of the other two species, of the genus *Marmota,* which live farther south. In some areas, wariness is directly proportionate to the amount of hunting by Eskimos. In areas of the Brooks Range where man has seldom or never been, the marmot is least wary. Weather, to a great extent, controls activity of the marmot. This control is indirect. Mosquitoes are most active on quiet, warm cloudless days and drive the marmots below ground. Marmots are more active on days when there is wind enough to drive the mosquitos to the ground and are most active when a brisk wind is combined with cloudiness and coolness. At Chandler Lake there was a period of five relatively windless days in which the marmots were neither heard nor seen. The sixth day was windy, cloudy, and cool and marmots were conspicuously active. As stated above, man has, in local areas, such as at Chandler Lake, persistently hunted marmots and as a result, at least in 1951, they were extremely wary; when man was detected, marmots not only restricted their movements but also remained silent. Marmots that were members of a colony were less wary than individuals that lived alone. It is suspected that the degree of wariness is related to the amount and type of predation. Consequently, failure of a person to see or hear a marmot does not mean that there is none in a given area.

Different kinds of animals elicit different reactions from marmots. The call of the marmot is the warning signal. This call is not the loud single sharp note of *M. flaviventris,* but is a slurred cadence of lower pitch. The appearence of a golden eagle, a species that is numerous throughout the Brooks Range and probably the principal predator on the marmot, usually causes the marmot to give about four quick calls before he becomes silent. These calls are relayed throughout the colony as the eagle passes by. One of the marmots obtained above Lake Peters had healed-over gashes in the skin that could have been made by an eagle. Eagles were seen every day at Lake Peters cruising just above the rocky hillside at an altitude of about 3800 feet—the elevation on the mountain slope at which there are the most marmots. An interesting variation in the hunting tactics of the eagle was to circle upwards in one steep drainage gully and then plummet almost to the bottom of the next adjoining gully. An ermine was seen to pass a marmot 40 meters away without the latter giving alarm. Dall sheep which live in the same area as the marmot usually do not alarm it. The marmot seems to react differently to animals on the floor of the valley than to those on the hillside where the marmot is, and if one sees a Dall sheep, a lone caribou or wolf crossing a canyon floor, the marmot (generally the one nearest) calls continously but not with the same alertness as when an eagle is passing. As a man leaves the valley floor and approaches a marmot den, the marmot generally calls once or twice and then remains silent and frequently retires out of sight. In the Chandler Lake area on each of the five occasions when we entered the territory of a particular marmot she called once when we were 200 meters distant and then remained quiet while we searched the area. At Lake Peters two marmots called at a place 200 meters away from the observer, and called once more when he approached to within 100 meters. The observer was able to stalk to within 40 meters and shoot three times, finally hitting one of the animals. It dropped into the rocks and the other followed. When the observer was directly over the den one animal called from beneath the rocks and on other occasions uninjured animals have been known to call when a person was directly over the den. The following day only one marmot was seen in the above-mentioned area. Ordinarily a pair of marmots will remain above ground longer than a single marmot and they will go into the rocks when the observer is 50 meters away, whereas a single marmot will go in at about 200 meters. If a pair is stalked and surprised by firing at close range, they will remain above ground for several seconds, especially if one is injured. At Lake Peters, near Chamberlin Canyon, two marmots were near one another and were stalked to within 20 meters before the lookout, a male, saw the hunter and called sharply and then dropped down on the other side of the observation rock and ran about 10 meters into his den. The female instantaneously left her grazing area at the call of the male and ran to a vantage point directly in front of the observer. Although shot here she ran 13 meters to within 1 meter of her den before she died. The male recognized a distress call of the female and came out of his den and stood upright on the rock directly above the entrance, and was shot. He entered the den, which was opened up to retrieve him. Each one of this pair of marmots had a separate den near one observation point.

The area selected for denning is generally so placed that it excludes most of the larger mammals such as the caribou, Dall sheep and even the grizzly bear. In the areas that marmots use for foraging at the edges of rock fields, marmots come in contact with the kinds of large mammals mentioned immediately above and with many other kinds of smaller mammals. Caribou and Dall sheep graze on areas used by marmots for foraging.

Of the small mammals, the red-backed vole is most intimately associated with the marmot. The singing vole is mostly confined to the foraging areas beyond the rock fields.

At the mouth of Chamberlin Canyon a ground squirrel came to within one meter of a resting marmot and remained there until the marmot retreated to its rock protection as we approached. The ground squirrel left immediately and ran 20 meters, paused just long enough to give one sharp call, and disappeared into its burrow. In 20 minutes the ground squirrel returned to the rocks in which the marmot had its den but the marmot did not reappear in the 2 hours that we watched for it. If there is mutual benefit in the warning calls of each of these animals, the ground squirrel probably benefits the more; in five instances in which the two species were found together the marmot detected our approach first.

One morning we excavated a den to retrieve a marmot that was wounded the evening before. Five minutes after the marmot was killed, mosquitoes occupied every available surface, particularly around the mouth and eyes and nose, and many areas supported several layers of these insects. This suggested to us the reason for the marmots choice of windy days to be above ground—days on which the mosquitoes were kept inactive by the wind.

In the course of six days, August 18-24, 1951, a large adult female and her subadult offspring were observed to move up a steep mountain ridge of outcroppings and slides of rocks from about 3,000 to 4,500 feet. On the second day five traps were set at intervals along this ridge in positions which showed considerable use by the two marmots. They moved higher, beyond the trap-line, and so far as known never returned to the lower limits occupied when we first saw them. Possibly the upward movement of the marmots was in response to our interference in the area or possibly they were moving upward as a normal adjustment to autumn weather in preparation for hibernation.

This herbivore eats prodigious amounts of vegetation. The adult female shot on August 25, at Chandler Lake, weighed 3181 grams and the stomach (270 grams) and intestines (580 grams) with contents made up more than a fourth of the total weight. A subadult shot on August 24 at the same place had the abdomen greatly distended and weighed 1843 grams. The stomach (250 grams) and intestines (410 grams) with their contents made up more than a third of his total weight!

Mr. James R. Anderson of Bettles owns a parka made by an Eskimo which was fashioned from 20 skins of hoary marmots taken in the Brooks Range. Most of the skins were essentially the same color as those taken by us at Chandler Lake. A few of Anderson's skins, however, were browner than ours. He values this parka at $350.00. An individual skin has a commercial value of from $6.00 to $8.00. He says that one Eskimo will spend all summer collecting enough skins to make one parka. The Eskimos do not like to hunt marmots because they are difficult to capture; they generally are caught in rockfall traps. Several Eskimos working at Bettles had never seen this animal in their hunting experience in the Bettles area.

The two sites most commonly chosen for dens are extensive fields of boulders and rockslides or rock outcroppings. Most dens are directly below, or within 10 meters of, an elevated observation point, which in almost all instances permits the marmot to see for long distances in all directions. We have never studied a den in a boulder field because of the difficulty involved in exposing the den but did study one at the south end of Lake Peters. This den was on a high, steep canyon wall at 3690 feet and was 7 meters away from a vantage point. The entrance, tunnel and nest chamber were natural features resulting from two large boulders lodging on a ledge. The arrangement excluded all predators except the ermine. The entire space was walled with solid rock except a part of the roof above the nest chamber which was, however, completely sealed in with large boulders and soil. The chamber was about three times the size of the marmot and was lined with dry yellow grass stems. The nest material could be seen from the entrance.

Another den excavated at Chandler Lake was similar to the one at Lake Peters in that each was at the edge of an extensive rock field rather than within the rock field. The tunnel of the den at Lake Peters led downward among loose rock to the nest whereas the tunnel of the den at Lake Peters was horizontal. When the den at Chandler Lake was approached, an adult female was on a lookout station seven meters from the den. She ran into the den as did a subadult that had leaves in its mouth but it paused several seconds at the edge of the den before following her underground.

In unconsolidated rock fields the uneaten food, the nest material, the fecal pellets and some excavated soil help to build up soil rich in organic material. These soils are important at one stage in the xerosere succession.

Marmots were active at Chandler Lake on August 25, 1951, when the temperatures were below freezing and when smaller mammals captured in traps froze solid and small ponds and running creeks were covered with a thin layer of ice. At Lake Peters marmots were still active after the first major snow storm of autumn on August 15, 1952.

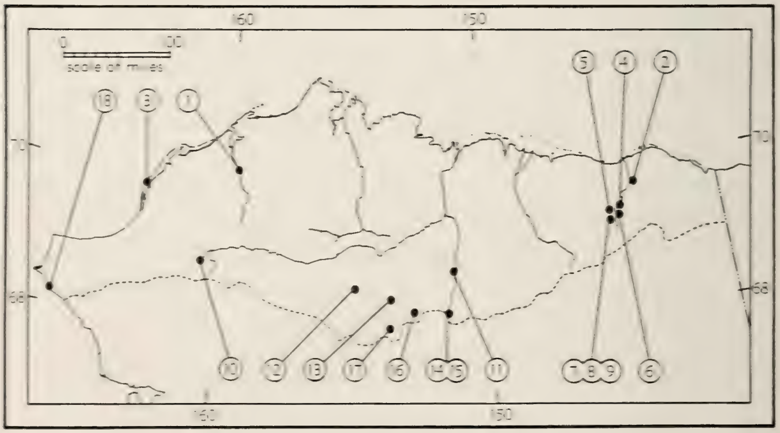


FIG. 12. Record stations of occurence for *Marmota caligata broweri.*

Records of occurrence.—Specimens examined, 7: Nos. 43227, 43228, 50417-50421. Nos. 50419-50421 are skulls-alone. The specimens are distributed by localities as follows: (6) mouth of Chamberlin Canyon, S end Lake Peters, 145°08'34", 69°20'58", 3690 ft., Brooks Range, 2; (7) S end Lake Peters, 145°

09′50″, 69°20′15″, 2906 ft., Brooks Range, 3; (16) Chandler Lake, 152°45′, 68°12′, 2900 ft., 2.

Additional records: (1) 50 mi. inland from Wainwright (Bailey and Hendee, 1928:20); (2) Hulahula River in foothills S of Barter Island (Anderson, 1934a: 61); (3) Point Lay, Arctic Coast of Alaska (Hall and Gilmore, 1934:57); (4) S end Lake Schrader, 145°08′30″, 69°24′30″ (J. W. Bee, MS, 6 July 1952); (5) Whistler Creek, 145°15′00″, 69°20′30″ (seen by Marvin Mangus and J. T. Dutro on 26 July 1952—*fide* J. W. Bee, MS, same date); (8) Mount Mary, 145°10′, 69°21′ (J. W. Bee, MS, 1 August 1952); (9) Mount Mary, 145°11′, 69°20′ (J. W. Bee, MS, 13 August 1952); (10) headwaters of Colville River (seen by Charles Hummel, June and July in 1950—*fide* J. W. Bee, MS, 11 June 1952); (11) 30 to 35 mi. N. Tulugak Lake (Rausch, 1951:178); (12) Kurupa River, 155°00′, 68°30′ (seen by William Steere on 1 July 1952 —*fide* MS of J. W. Bee same date); (13) [Endicott mountains (Brooks Range) but definite localities unspecified] Anderson *in* Stefansson, 1913b:510; Miller, 1924:177; Dufresne, 1946:133; Burt and Grossenheider, 1952: 63); (14) about 10 mi. S of Tulugak Lake (Rausch, 1950c:466; 1951:178); (15) Anaktuvuk Pass (Rausch, 1951:178; 1953:116); (17) head of Killik (Rausch, 1951:178); (18) Cape Thompson, Arctic Coast of Alaska (Hall, 1929:422; Hall and Gilmore, 1934:58).

Spermophilus undulatus kennicottii (Ross)
Arctic Ground Squirrel (Sikrik)

A[rctomys]. kennicottii Ross, Canadian Nat. and Geol., 6:434, 1861, based on specimens from the lower Mackenzie region.

Arctomys parryii, Harlan, Fauna Americana, p. 170, 1825. (Also Godman, 1826, Vol. 2:120.)

Arctomys (Spermophilus) Parryi, Richardson, Fauna Bor.-Amer., Pt. 1, p. 158, 1829. (Also Richardson, 1839:7.)

Spermophilus empetra var. *empetra,* J. A. Allen, Rept. Geol. Surv. Terr., 11:845, August, 1877.

Spermophilus empetra empetra, Nelson and True *in* Arctic Ser., No. 3, issued in connection with Signal Service, U. S. Army, p. 233, 1887.

Spermophilus empetra, Murdock *in* Expedition to Point Barrow, Alaska, Exec. Doc., No. 44 (48th Congress, 2nd Session) by P. H. Ray, p. 103, 1885. (Also W. Stone, 1900:43.)

Spermophilus (Colobotis) empetra, Trouessart, Catalogus mammalium tam viventium quam fossilium, p. 435, 1898-99.

Spermophilus barrowensis Merriam, Washington Acad. Sci., 2:19, March 14, 1900, type from Point Barrow, Alaska. (Also Elliott, 1901:91; Preble, 1908:162.)

Spermophilus beringensis Merriam, Washington Acad. Sci., 2:20, March 14, 1900, type from Cape Lisbourne (coal veins), Alaska.

C[itellus]. barrowensis, Osgood, Proc. Biol. Soc. Washington, 16:25, March 19, 1903.

Citellus barrowensis, Miller, Bull. U. S. Nat. Mus., 79:296, December 31, 1912. (Also Bailey and Hendee, 1926:20.)

Citellus (Colobotis) parryi empetra, Trouessart, Catalogus mammalium tam viventium quam fossilium, p. 338, 1904-5.

Citellus (Colobotis) parryi kennicotti, Preble, N. Amer. Fauna, 27:162, October 26, 1908.

Citellus parryi kennicotti, Miller, Bull. U. S. Nat. Mus., 79:296, December 31, 1912. (Also Anderson, *in* Stefansson, 1913c:510.)

Citellus parryi kennicottii, Hall, Univ. California Publ. Zool., 30:423, March 19, 1929. (Also Dufresne, 1946:136.)

Citellus (Colobotis) beringensis, Trouessart, Catalogus mammalium tam viventium quam fossilium, p. 338, 1904-05.

Citellus beringensis, Miller, Bull. U. S. Nat. Mus., 79:296, December 31, 1912. (Also Gilmore, 1934:322.)

Citellus parryii parryii, A. H. Howell, N. Amer. Fauna, 56:91, May 18, 1938.

Citellus parryii barrowensis, A. H. Howell, N. Amer. Fauna, 56:95, May 18, 1938. (Also Rausch, 1951:179.)

Citellus parryi barrowensis, Rausch, Jour. Mamm., 31:466, November 21, 1950. (Also Mayer, 1953a:334; 1953b:48; 1953c:607.)

Citellus parryi, Burt and Grossenheider, A field guide to the mammals, Houghton Mifflin Company, Boston, p. 66, 1952.

Citellus undulatus parryii, Rausch, Arctic, 6:121, prior to October 2, 1953.

Citellus undulatus barrowensis, Rausch, Arctic, 6:122, prior to October 2, 1953.

Description.—A medium sized (16 inches long), long-tailed (5 inches long), reddish-gray ground squirrel.

Average and extreme measurements of 14 males and 11 females, all adults, from an area two miles across along Lake Schrader and Lake Peters, are, respectively, as follows: Total length, ♂ 398 (383-421), ♀ 386 (349-399); tail, 123 (119-135), 118 (112-126); 60 (58-65), 59 (57-61); ear from notch, 11.9 (11-15), 12.5 (10-15); weight (27 July to 9 August), 678 (605-854), 732 (615-835—all non-pregnant); greatest length of skull, 59.7 (57.4-62.0), 58.2 (56.9-59.0); palatilar length, 30.1 (28.8-31.3), 29.6 (28.7-30.6); zygomatic breadth, 39.2 (37.2-41.0), 37.7 (36.1-38.9); cranial breadth, 23.7 (22.8-25.0), 22.9 (21.7-24.1); interorbital breadth, 12.6 (11.8-14.1), 12.0 (10.6-13.2); postorbital constriction, 13.6 (12.5-15.1), 13.3 (12.9.14.5); greatest length of nasals, 21.1 (19.5-22.2), 20.8 (19.4-22.0); least width of nasals, 6.3 (5.3-7.1), 6.1 (5.4-6.6); length of incisive (anterior palatine) foramina, 3.8 (2.9-4.6), 4.1 (3.3-5.0); crown length of maxillary tooth-row, 13.0 (12.3-14.0), 13.2 (12.7-13.6). Top of head (July 27, fresh pelage) near (*l*) Russet; side of face Cinnamon Buff to Ochraceous Buff; shoulders near (*h*) Ochraceous-Orange; back and posterior half of sides Bister irregularly flecked with spots (4 mm in diameter) of buffy white; front and hind legs Ochraceous-Tawny; underparts near (16'*h*) Ochraceous-Tawny; tail blackish above, especially distally, conspicuously edged with Ochraceous-Tawny; underside of tail near (*j*) Tawny, widely (30 mm) bordered at tip with black. In winter pelage said to be paler (grayer) .

Remarks.—Specimens from Umiat include five adults. They were collected on June 28 and each had acquired approximately a fourth of the fresh summer pelage. Of adults collected at Wahoo Lake in the period July 4-11, seven had completed the molt and the others had acquired much of the new pelage. Of 18 adults, from Lake Schrader and Lake Peters, collected from July 27 to August 9, all but seven had completed the molt. These seven, one male and six females, were taken in the earlier part of the period. In every instance where specimens taken on the same date were examined for molt, females were less advanced. And as a result they seemed to be paler than males. Of ten adults collected at Chandler Lake from August 10 to 25 all have completed the molt, as have the four adults from the Utukok River collected from

August 28 to August 31. We did not obtain specimens at a later date.

Specimens from the Utukok River and especially those from Chandler Lake are paler (yellowish instead of reddish or hazel) both above and below than those from places farther west.

Size may be correlated with altitude; at low elevations squirrels are largest and at high elevations they are smallest. Possibly, however, there is a trend from largest in the west to smallest in the east; we lack specimens from the mountains in the west to test this possibility. Length of incisive foramina is subject to local variation; on the Utukok River, the length of these foramina averages 5.3 (4.9-5.7) in four males, whereas corresponding meas-

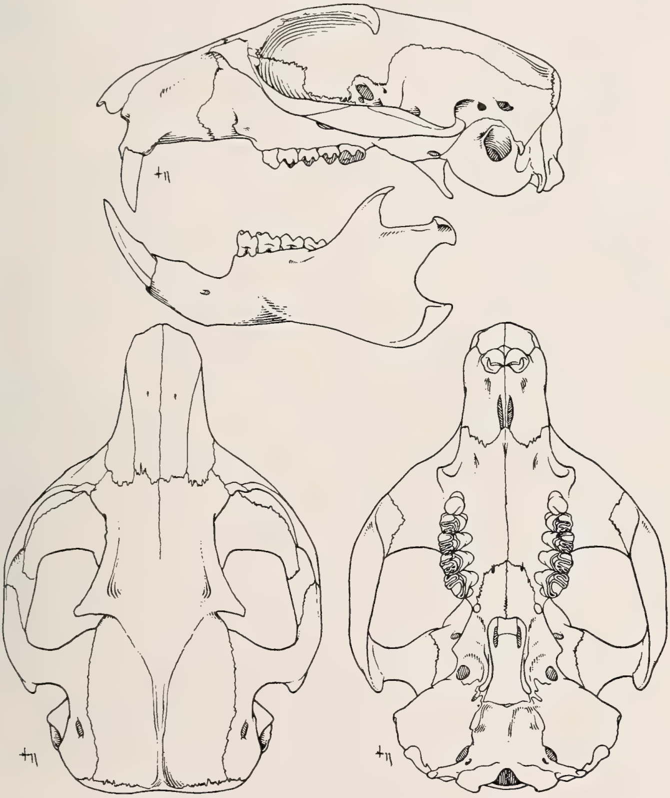


FIG. 13. Skull of *Spermophilus undulatus kennicottii,* Bearpaw Creek, $1\frac{7}{10}$ mi. N and $1\frac{7}{10}$ mi E. Umiat, 152°04′50″, 69°23′30″, 550 ft., June 28, 1952, No. 50437 KU, ♂. × 1.

urements for 14 males from Lake Peters and Lake Schrader are only 3.8 (2.9-4.5). However, we are unable to detect any cline in this feature.

In 1908 Preble in his "A biological investigation of the Athabasca-Mackenzie Region" (pp. 162-164) concluded that the name *parryii* proposed in 1825 by Richardson was available for the Arctic ground squirrel of northern Keewatin and eastern Mackenzie, second that *kennicottii* proposed in 1861 by Ross on the basis of specimens from "the lower Mackenzie region" was available in the subspecific sense for the Arctic ground squirrel of northwestern Mackenzie, northern Yukon and the northern coast of Alaska, and that the later (1900) proposed names of Merriam, S. *barrowensis* from Point Barrow, Alaska and S. *beringensis* from Cape Lisburne, Alaska, were synonyms of S. *kennicottii.*

In the ensuing 30 years additional specimens from northwestern Canada and some from the eastern part of northern Alaska were collected. In 1938 when A. H. Howell in his "Revision of the North American ground squirrels . . ." (p. 95) reported his findings he found that most of the specimens (incidentally mostly collected after 1908) from northwestern Canada were as dark as specimens of *parryii* from farther east along Hudson Bay. Consequently, Howell (*loc. cit.*) applied the name *Citellus parryii parryii* to the Arctic ground squirrels from Hudson Bay westward into the eastern part of northern Alaska. He placed Ross' name *kennicottii* as a synonym of Richardson's earlier name *Arctomys parryii.* Howell revived Merriam's name *barrowensis* and applied it to the (as he thought paler) animals from Point Barrow westward to Point Hope. Howell arranged Merriam's name *beringensis,* based on specimens from Point Hope, as a synonym of *barrowensis.*

Our own independent study convinces us that Preble was correct and that Howell was incorrect. Howell failed to realize that the dark color of most of the specimens that he saw from the eastern part of northern Alaska, from northern Yukon and from northwestern Mackenzie, was owing to the skins having been dried, in some instances after being salted, and then later, at the United States National Museum, being relaxed and stuffed there. This treatment resulted in a darker appearance for at least two reasons: In the first place the skins were not fully relaxed and are of lesser circumference when stuffed with the result that the dark tips of the hairs are closer together and reveal less of the paler color deeper in the pelage. In the second place, in skins that have been salted the reds are intensified. The skins that were stuffed in the field without first being dried, or dried and salted, are paler. Howell may or may not have been misled to some degree also by seasonal difference in color of pelage. Most adults in July and August are in the darker summer pelage; animals taken in September frequently are acquiring the paler winter pelage which is retained into June.

Specimens from the west shore of Artillery Lake and from Casba (Kasba) Lake in eastern Mackenzie and those from 25 miles south of Cape Eskimo on the western side of Hudson Bay in Keewatin are naturally dark. It is a reasonable assumption that they closely resemble specimens (none available) from the type locality of *Arctomys parryii* at Five Hawser Bay, Lyon Inlet, Melville Peninsula. On the basis of this assumption the subspecific name *Spermophilus undulatus parryii* (Richardson) will apply to the animals at least as far west as Artillery Lake (109°).

Specimens from Fort Anderson (128°), Old Fort Goodhope, and those from as far west at least as Point Hope, Alaska, are paler and will take the earliest available name, which is *Spermophilus undulatus kennicottii* (Ross).

We have not examined Canadian specimens from between Fort Anderson to the west and Artillery Lake to the east. Consequently we are unable to say where in this region the dividing line should be drawn between *S. u. kennicottii* and *S. u. parryii.*

The first available name for the species as a whole seems to be *Mus Citillus undulatam* Pallas 1778 (Novae species quadrupedum . . . Erlangae) [the chapter heading is "Mus Citillus," and on page 127 of this chapter there is mention of the variety "undulatam"]. Rausch (1953:121) has used the specific name *undulatus* for ground squirrels of Asia and America to show their conspecificity in the two continents. We follow him because one of us (Hall, 1932:396-397) ascertained that *Citellus lyratus* Hall and Gilmore, of St. Lawrence Island, more closely resembles Asiatic animals than Alaskan animals; the animal from St. Lawrence Island now is accorded only subspecific status under the species of the Alaskan mainland.

The Arctic ground squirrel is found throughout the Arctic Slope except in areas around Eskimo dwellings, and is a common and conspicuous mammal wherever found.

This squirrel is best adapted to carry on the life processes of feeding, hibernating and evading enemies in areas where permafrost is several feet below the surface of the ground. North of the Brooks Range, such areas generally are well drained slopes. The following physiographic types were used by ground squirrels on the Arctic Slope: stabilized aeolian deposits and sand dunes, either removed from, or directly associated with, lakes, creeks and rivers; erosional banks of various types of soil either associated with, or removed from, bodies of water; islands of sandy soils in meandering river courses; knolls and isolated ridges in valleys; stabilized parts of alluvial fans; elevated river benchlands in valleys, principally along the brink of a bench; dry sidehills or valley slopes especially on prominences; deep sandy soils from overflow of creeks on sidehills or from the sides of valleys; local shaly or loose soils on slopes; crests of ridges on windswept divides; ledges with natural holes; soils among stabilized rock fields on hillsides or sides of canyons. Each of the mentioned sites of which ninety per cent were equally divided between southern and western exposures was characterized by good drainage and a minimum of interference from the underlying permafrost. The optimum conditions for colonization are: 1) loose soils on well drained slopes; 2) vantage points from which the surrounding terrain can be observed; and 3) bare soils surrounded by vegetation that is in an early xerosere stage of succession. At our camp on the Kaolak River, ground squirrels inhabited sandy ridges, especially those higher than the surrounding country and the upper edges of the bluffs of the river valley; however, one actively used burrow was only two-thirds of a meter from the edge of the river. In previous years the ground squirrels used flat tundra beyond the bluffs, but at the time of our investigations in 1951 were confined to the river valley. At Topagaruk on July 5, 1951, there were numerous ground squirrel burrows from the edges of the river to the top of sand dunes, which were nine meters high. The burrows along the river had been inundated by high water in spring. There were four or five holes on each of 25 sandy mounds examined. At Teshekpuk Lake (NE edge) there were burrows in banks three meters high. A beach of sand pebbles separated these banks from the lake. There was flat upland tundra immediately above the banks. Caribou continued to modify these banks by trampling. At Umiat, on June 27, ground squirrels were common on the sides of the valley of the Colville River. On the upper edge of the river valley they were using holes on bare ridges of loose soils made by wind erosion. Most of the squirrels, when approached by us, ran down the slope into holes under the protection of alder and willow shrubs or into deep fractures in the ledges immediately below the ridge. Elevated prominences on the sides of the river valley were most commonly inhabited; however, side canyons leading from the river valley also were used, especially wherever there were large boulders and rock outcroppings. A few squirrels were living on the highest point on Mount Umiat within 15 meters of a duck hawk nest. At Gavia Lake on August 21, squirrels were living on eroded edges of the numerous ox-bow lakes and on the higher stabilized mounds bordering these lakes. At Driftwood, squirrels were associated with eroding surfaces in the river valley, especially along the old benchlands. Thomas Cade and George

Schaeller reported the ground squirrel as common along the Colville River from the mouth of the Etivluk River to within 10 miles of the Arctic Ocean. These squirrels were most frequently seen on sand dunes along the edge of the river. Subadults were more numerous than adults. At Porcupine Lake, on July 17, ground squirrels were found from the edge of the lake at 3140 feet to the top of Mount Annette at approximately 5,700 feet. Jurassic shales in the synclinal valley of Porcupine Lake provided ideal surfaces for the development of ground squirrel colonies. The most common sites were on bare ridges, knolls, and prominences on hillsides above the valley floor. Approximately one mile south of Barrow Village, in cliffs along the seashore, old holes of ground squirrels were exposed in cross section. At Lake Schrader and Lake Peters this ground squirrel occupied slopes from the floor of the valley high onto the mountain sides, especially on the bench lands approximately 120 feet above the lake. Higher on the mountains this ground squirrel occasionally lived among the large boulders of rock fields wherever soils were present. These squirrels are associated with large bodies of water, such as Lake Peters. None was seen above 3773 feet in Chamberlin Canyon, which is a tributary of the main canyon in which Lake Peters and Lake Schrader are situated, nor more than 1¼ miles up the main canyon (3100 feet) beyond the south edge of Lake Peters. Living on the edge of the lake may be advantageous for ground squirrels in that land carnivores can approach the squirrels from an arc of only approximately 180° instead of from 360°. Nearly all of the low ridges and knolls on the west side of Lake Schrader had colonies of the ground squirrel. Some individual holes were within 5 meters of the lake. The fracture systems in the soils along the edges of Spawning Creek, which enters Lake Schrader, made protected runways in which ground squirrels could obtain aquatic grasses and sedges along the creek. This foraging area was 40 meters from the nearest colony. Ground squirrels at Chandler Lake had much the same habitat preference as those at Lake Peters; benchlands and prominences of the hillsides are most commonly used. Ground squirrels did not inhabit narrow lateral canyons but were confined principally to the main valley of Chandler Lake.

The climate, which controls the ground squirrel community, has its most pronounced effect in early summer and late autumn. A high order of physical tolerance is required for the ground squirrel to be active, as it is, in rainy weather, freezing temperatures, snow storms, winds of high velocity, and dense ground fog. On a few occasions, especially when being chased, ground squirrels ran through shallow ponds. In spring, the water from melting snow inundated many of the marginal habitats and communities occupied by the ground squirrel, especially on the lower areas of the Coastal Plain. Most of the colonies are in high areas, or well drained slopes, where water affects the colonies only in spring and late autumn. Hibernation protects the ground squirrel from the low temperatures of winter.

Plants utilized generally are of early successional stages such as grow on edges of cut-banks, slopes, or on shales. Of these plants, willows are most important for overhead protection but other plants such as dwarf birch and alder, which are similar to willows in life-form, also are used. Each of these three plants is eaten to some extent. Availability of plants largely determines the extent of their use both for protection and for food. Squirrels inhabiting areas adjoining marshes, for example, use the grasses and sedges of these wet areas. The grasses most commonly associated with the ground squirrel at Teshekpuk Lake are: *Eriophorum* sp., *Arctogrostis latifolia* (R. Br.) Griseb. *Hierochloe alpina* (Swartz) Roem. and Schult., *Festuca ovina* var. *brachyphylla* (Schult.) Piper, and *Trisetum spicatum* (L.) Richt. Mushrooms near areas inhabited by the ground squirrels are eaten around the edges or on the upper surface.

Because ground squirrels travel long distances and forage in many different associations, these animals conceivably could eat almost every palatable kind of plant or shrub on the Arctic Slope.

The Arctic ground squirrel has a high degree of tolerance for all smaller mammals within the community and a passive resistance for the larger, herbivorous mammals.

The ermine is perhaps the most important natural enemy of the ground squirrel but leaves fewer evidences of its predation than does the grizzly bear, which digs extensively to reach the squirrels. At Chandler Lake there was a hole on a willow-covered mound of excavated soil on a hillside supporting a sparse growth of mosses and lichens and separated by 60 meters of inhospitable hillside from any other place suitable for the ground squirrel or the ermine. This hole seemed to be a temporary shelter or relay station between disconnected communities supporting ground squirrels. The results of the captures from the single trap set in the mouth of the burrow are as follows (inspections made at 8:00 A.M. and 4:00 P.M. daily):

August 10	4:00 P.M.	Trap set
	8:00 P.M.	♂ ground squirrel 340 mm in length, testis 8 mm
August 11	8:00 A.M.	♂ ermine 395 mm in length
	4:00 P.M.	♀ ground squirrel 363 mm in length, uterus normal
August 12	8:00 A.M.	♂ ermine 340 mm in length
	4:00 P.M.	Trap unmolested
August 13	8:00 A.M.	♂ ground squirrel 277 mm in length, testis 4.5 mm
	4:00 P.M.	Trap unmolested
August 14	8:00 A.M.	♂ ground squirrel 361 mm in length, testis 13 mm
	4:00 P.M.	Trap unmolested
August 15	8:00 A.M.	♂ ground squirrel (foot)
	4:00 P.M.	Trap unmolested
August 16	8:00 A.M.	♂ ground squirrel 393 mm in length, testis 9 mm
	4:00 P.M.	Trap unmolested
August 17	8:00 A.M.	♂ ground squirrel 375 mm in length, testis 10 mm

From this isolated burrow, 9 ground squirrels (8 males and 1 female) and 2 male ermine were taken. Our records show ten other instances of the ermine having been taken from burrows used by the ground squirrel. There were twelve instances of depredation by the ermine on the ground squirrel held in traps. Also, ermines were seen working around colonies of ground squirrels. Obviously the two species are closely associated. We trapped ground squirrels for eight consecutive days in a colony at Wahoo Lake. On the 7th day, after 22 ground squirrels had been taken, an ermine was trapped. We took four ermine from one trap at an isolated hole approximately 100 meters beyond the limits of another colony. In a mound along the edge of Chandler Lake, three ermine and only one ground squirrel were trapped from 14 holes. At Wahoo Lake, on July 10, one trap in a caribou trail caught a ground squirrel, an ermine, and two ptarmigan in that order in 20 hours. Ground squirrel holes along the brink of the benchlands above Lake Peters were commonly used by the ermine. We left a dead ground squirrel there within three meters of its burrow, from which two ermine then were taken while the dead squirrel remained untouched.

The grizzly bear in the Brooks Range is perhaps the second most important enemy of the ground squirrel, at least in those areas where the bear lives. The wolf, which has a wider distribution on the Arctic Slope than the bear, does not hunt ground squirrels so much as the bear does if digging for this squirrel can be used as a criterion. Squirrel burrows dug into by wolves were seen but such diggings were uncommon; the wolf may capture ground squirrels by surprising them above ground. At Mount Annette and at our camp on the Kaolak River, skulls of the ground squirrel were found in the fecal droppings of the wolf. Elsewhere we observed wolves in areas where the ground squirrel was common.

Of all of the smaller mammals, the singing vole is most closely associated with the ground squirrel, especially in the Plateau Province and Brooks Range Province. This association is one of tolerance on the part of the squirrel as concerns the use of willow as a food and shelter. The singing vole has been trapped in runways used by the ground squirrel and within one meter of the squirrel's burrow. One squirrel burrow was within four meters of the vole's forage pile. A higher percentage of mouse traps is sprung in colonies, of the vole, containing burrows of ground squirrels than in other colonies. One ground squirrel at Chandler Lake ate a dead brown lemming. At Spawning Creek the singing vole was the only small mammal trapped with the ground squirrel in fissure runways paralleling the creek; these fissures were about 30 meters from the ground squirrel colony and were used as grazing areas by the ground squirrels.

We suspect that the wolverine preys importantly on the ground squirrel. Tracks of the wolverine were noted several times in areas used by the ground squirrel.

The gyrfalcon probably catches ground squirrels on the Plateau and Coastal Plain. In the Brooks Range the golden eagle probably catches many ground squirrels because it is relatively common and habitually hunts along those ridges supporting the largest populations of squirrels.

The relationship between the ground squirrel and the hoary marmot is one of mutual benefit. At Lake Peters, some of the ground squirrels, which were found high on the mountain slopes, were in colonies composed of both ground squirrels and marmots. At various times of the day for seven days, we observed a ground squirrel resting upon a rock within one meter of a marmot. When approached, the marmot would give the warning signal first. The sight and hearing in the marmot prove to be superior although these senses are also highly developed in the ground squirrels. At Chandler Lake, ground squirrels were trapped in high rock-fields at the entrances to holes used by marmots. During the latter part of August at Chandler Lake there was an altitudinal shift upward, by a group of ground squirrels into territory recently deserted by marmots that had moved still higher up the slope.

On slopes of the Brooks Range, where man has not hunted ground squirrels, the colonies of this species are large and compact whereas on floors of canyons and wherever else Eskimos have repeatedly hunted these squirrels they are fewer, more widely spaced and wary. Eskimos on the Arctic Slope trap, snare and shoot ground squirrels and use the fur for parkas. When Eskimos are inland, away from the coast, they extract fat and oil from squirrels by boiling and eat the fat along with lean meat of other animals. At our camps at Kaolak River, Kaolak, and Chandler Lake, the ground squirrels had been harassed and hunted and they were seldom seen or heard by us although they were in the area, whereas at Wahoo Lake and Porcupine Lake they were noisy and conspicuous during the day. At our camp on the Kaolak River, only one ground squirrel was taken from each of the several mounds trapped. In several semipermanent field camps, men so tamed some ground squirrels that they remained around the camps and came upon call. Where ground squirrels rarely or never see men but where predators catch many squirrels, those on the upper reaches of slopes are more conspicuous in their movements and call sooner and more persistently than those lower down near the valley floor. In areas where natural enemies capture many squirrels, those that remain tend to crawl on their bellies instead of walking as do squirrels in other areas.

Whenever individuals are trapped for several consecutive days from a colony, the females are trapped out before the males, possibly because males, sooner than females, wander in from adjacent colonies after the original squirrels have been removed. After the adult females are removed, squirrels so young as hardly to be capable of leaving the nest always are trapped, presumably being prematurely forced out of their burrows by hunger.

The ground squirrel has a variety of calls, two of which are commonly heard. One is a sharp high-pitched call and the other is a double call given in quick succession and possibly of lower pitch. The latter call is the one that the Eskimos have attempted to imitate in their word sic-rik, which is the name employed by the Eskimos for this squirrel. When a person handles ground squirrels that have been trapped, they will sometimes squeal in fear or rapidly chatter their teeth in defiance.

An actual count was made of 175 ground squirrels inhabiting an area of ridge, three-fourths of a mile long, north of the west peak of Mount Annette. These were in family groups of from three to seven. On the north side of Porcupine Lake we counted 70 ground squirrels on approximately four acres of hillside.

Because some vegetation is covered by soil excavated from burrows and because other vegetation between burrows is trampled and eaten, there often is a bare area approximately 10 meters across in a colony of only six or eight burrows. Outside the colony proper there is only slight effect of squirrel-activity except where surface trails connect. Trails on steep bare banks promote erosion there; otherwise rapid growth of plants would quickly cover the surface. Dusting pits in loose soils enlarge and maintain bare areas. Debris and new soils brought to the surface from burrows add greatly to the fertility of the top soil. Soil excavated from one burrow covers two square meters of ground and on sidehills as much as four square meters. At Kaolak River on July 17, 1951, damp sands were being brought up from newly excavated burrows.

Old unused holes were seen in the floors of canyons, and on the climax tundra adjoining areas of optimum habitat, and in some abandoned colonial burrows on sidehills vegetation was in late successional stages. It seemed that recently there had been a larger population of ground squirrels. Wolves normally travel on the floors of the canyons and at times may eliminate many of the squirrels there, or excessively wet weather may saturate soils and drive out the ground squirrels. A large percentage of the isolated burrows in marginal areas, as on the floors of canyons at Porcupine Lake and in the Lake Schrader-Lake Peters area, had been opened by the Arctic grizzly. Max Brewer collected two ground squirrels on the Inaru River, approximately 156°30′, 70°54′ on June 3, 1951, at which time the greater part of the ground surface was covered with snow.

The Arctic ground squirrel is one of the first mammals to take up residence in an area that is in an early stage of plant succession. As already stated, the squirrel creates bare areas on hillsides by extensive digging of burrows and trampling, as at Mount Annette and on the north side of Porcupine Lake. Most of these bare spots were on loose shaly, relatively barren soils, but others were on non-shaly soil that orginally supported shrubs, grasses, mosses and lichens. Within approximately 30 meters of a bare area used by a colony of ground squirrels, there was a consocies of grass in a late seral stage. Other areas more advanced successionally were being stabilized by the influx of mosses and lichens and shrubs. The abandoned colonies probably represent either an expanded use of the hillside during periods of high populations or a crowding out of the squirrels because of the normal succession of plants. If a burrow is dug in a hillside that supports climax mosses and lichens, the willow is one of the first plants to pioneer the soil newly excavated by the ground squirrel. As a result there is a remarkably high percentage of burrows, especially isolated burrows, associated with willow clumps. Sandy deposits, especially along the edges of rivers, are frequently maintained in an early xerosere by ground squirrels.

The Eskimos said that the squirrels generally came out of hibernation in early May and went in as early as the latter part of September and as late as late October. The disappearance of ground squirrels in autumn and their reappearance in spring, after hibernation, was thought to be governed by altitude and surface exposure.

Females collected between June 15 and September 4, had no embryos. Size of the testis decreases during summer. External difference between sexes of ground squirrels is slight. Both male and female have bare areas surrounding the mammae. The clitoris is nearly as prominent as the penis. Externally the female has a large vestibule of approximately 6 mm in diameter whereas in the male the urethra is only 3 mm.

Study of three animals taken at Umiat on July 28, showed how the total weight is influenced by the condition of the digestive tract. The digestive tract and its contents weighed only 196 grams in a female that was 408 mm in total length whereas the digestive tract weighed 300 grams in another female 404 mm in total length. The weights of various parts of the body of a third female measuring 403 mm in length were: body, 395; pelt, 128; digestive tract, 260; total weight, 785.

Records of occurrence.—Specimens examined, 165: Nos. 43229, 43230, 43234, 43235, 43238, 43240-43242, 43253, 50422-50425, 50432-50436, 50440-50460, 50467-50471, 50478-50481, 50485, 50486, 50488, 50489, 50498-50506, 50509-50521, 50523-50530; skulls alone 43231-43233, 43236, 43237, 43239, 50426-50431, 50437-50439, 50461-50466, 50472-50477, 50482-50484, 50487, 50490-50497, 50507-50508, 50522; U. S. Nat. Mus., skins and skulls 290280, 290282-290285, 292985, 292986, 292992; skins 60946, 107755, 107757, 107758, 107761-107764, 282648, 292993, 292995; skulls 116189, 116182, 116183, 116185, 120002, 175699, 175701, 175702, 175738, 192987-192990, 192994, 225744, 227089, 230839-230841, 230843, 230844; 1 specimen lacks a catalogue number. These are distributed by localities as follows: (1) Point Barrow, 16 (U. S. Nat. Mus.) (See also Nelson and True *in* Nelson, 1887:281; W. Stone, 1900:43; Elliot, 1901:91; Preble, 1909:162; Miller, 1912b:296; Howell, 1938:95.); (11) Wainwright Inlet, 1 (U. S. Nat. Mus., albino obtained in November 1895 for McIlhenney through Charles D. Brower) (See also Murdock *in* Ray, 1885:103; Howell, 1938:96.); (19) Kaolak River (Kuk River), 159°47′40″, 70°11′15″, 30 ft., 1; (25) East Oumalik, 114 mi. SSE Point Barrow, 3 (U. S. Nat. Mus.) (See also Mayer, 1953a:335.); (27) Gavia Lake, N White Hills, 150°00′, 69°35′, 460 ft., 4; (30) mouth of Anaktuvuk

River, 4 (U. S. Nat. Mus.); (31) Bearpaw Creek, $1\frac{7}{10}$ mi. E and $1\frac{7}{10}$ mi. N Umiat, 152°04′50″, 69°23′30″, 550 ft., 8; (32) $1\frac{3}{10}$ mi E and $1\frac{3}{10}$ mi. N Umiat, 152°05′30″, 69°23′12″, 500 ft., 6; (33) Umiat, 1 (U. S. Nat. Mus.) (See also Rausch, 1950c:466.); (35) SW Lake Schrader, 145°11′30″, 69°24′32″, 2925 ft., Brooks Range, 27; (36) SE end Lake Peters, 145°09′26″, 69°20′56″, 2950 ft., Brooks Range, 31; (37) 141°00′, 69°20′ [Alaska-Yukon boundary], 4 (U. S. Nat. Mus.); (38) Wahoo Lake, 146°58′, 69°08′, 2350 ft., Brooks Range, 18; (39) 2 mi. W Utukok River, 161°15′30″, 68°54′50″, 1275 ft., Brooks Range, 2; (40) Utukok River, 161°12′10″, 68°53′47″, 1200 ft., 1; (41) Driftwood, 161°12′10″, 68°53′47″, 1200 ft., Brooks Range, 2 (1, U. S. Nat. Mus. No. 292994 labeled as from 200 mi. SW Point Barrow, is actually from Driftwood); (42) Cape Lisburne, 3 (U. S. Nat. Mus.) (See also Miller, 1912b:281, 296; Howell, 1938:95.); (44) Porcupine Lake, 146° 29′50″, 68°51′57″, 3140 ft., Brooks Range, 10; (45) Mount Annette, 146° 28′51″, 68°50′38″, approximately 5700 ft., Brooks Range, 1; (47) Point Hope, 1 (U. S. Nat. Mus.) (See also Howell, 1938:95; Gilmore, 1934:322.); (49) Tolugak [Tulugak] Lake, 5 (U. S. Nat. Mus.) (See also Rausch, 1950c:466; 1953:122.); (50) Chandler Lake, 152°45′, 68°12′, 2900 ft., 14; (51) Anaktuvuk Pass, 2 (U. S. Nat. Mus.) (See also Rausch, 1951:179; Mayer, 1953a: 335.).

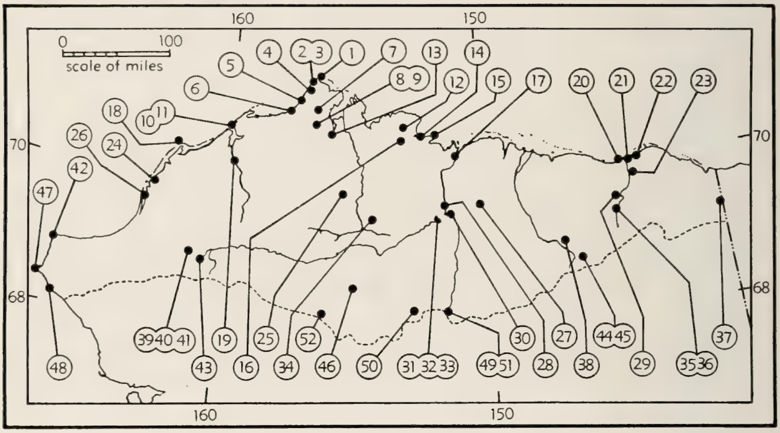


FIG. 14. Record stations of occurrence for *Spermophilus undulatus kennicottii.*

Additional records.—(2) Barrow (Hall, 1929:423); (3) Cape Smythe (Murdock *in* Ray, 1885:103; Nelson and True *in* Nelson, 1887:233); (4) 11 mi. S and 3 mi. W Barrow, 156°24′00″, 71°07′40″ (seen by Pete Savolik on July 8, 1951—*fide* J. W. Bee, MS, September 10, 1952); (5) Skull Cliff, 157°12′00″, 71°02′30″ (seen by Pete Savolik on July 8, 1951—*fide* J. W. Bee, MS, September 10, 1952); (6) ocean front 6 mi. S and 6 mi. W. Sinaru, 157°36′, 70°54′ (seen by Pete Savolik in 1937—*fide* J. W. Bee, MS, September 10, 1952); (7) W of cabin on Inaru River, 156°30′, 70°54′ (seen by Max Brewer on June 3, 1951—*fide* J. W. Bee, MS, September 5, 1952; Mayer, 1953a:335; Rausch, 1953: 122); (8) 43 mi. S of Point Barrow, Meade River (seen by Ira L. Wiggins in 1951—*fide* J. W. Bee, MS, July 11, 1951; Mayer, 1953a:335; Rausch, 1953:122); (9) on the Meade River, 30 mi. from Barrow (Hall, 1929:423); (10) just north of Wainwright (Bailey and Hendee, 1928:20); (12) NE Teshekpuk Lake, 153°05′40″, 70°39′40″ (J. W. Bee, MS, July 31, 1951); (13) Topagaruk, 155°48′, 70°34′, 10 ft. (J. W. Bee, MS, July 5, 1951); (14) 13 mi. W Atigaru Point, 152°25′00″, 70°33′30″ (seen by Clifford Fiscus on August 31, 1952—

fide J. W. Bee, MS, September 10, 1952); (15) Atigaru Point, 151°50′, 70°34′ (seen by Clifford Fiscus on August 30, 1952—*fide* J. W. Bee, MS, September 10, 1952); (16) mouth of Tugley River at Teshekpuk Lake (Mayer, 1953a: 335); (17) mouth Colville River, 150°55′, 70°20′ (seen by Thomas Cade—*fide* J. W. Bee, MS, July 21, 1952); (18) Icy Cape (Richardson, 1839:7); [Cape Thompson] to Icy Cape (J. A. Allen, 1877:845); (20) Collinson Point (Howell, 1938:95); (21) Sadlerochit River (Howell, 1938:95); (22) Okpilak River (Howell, 1938:95); (23) Hulahula River (Howell, 1938:95); (24) mouth of Kokolik River (Mayer, 1953a:335); (26) mouth of the Kukpowruk River (Mayer, 1953a:335); (28) the Colville River, north of the mouth of the Anaktuvuk River (Mayer, 1953a:335); (29) Sadlerochit River, 144°21′, 69°52′ (seen by Charles W. Whittington on August 30, 1948—*fide* J. W. Bee, MS, September 10, 1952); (34) [definite localities unspecified]: most northern regions in America (Harlan, 1925:172); whole northern extremity of continent to Behring's Straits (Richardson, 1829:158); Arctic America from [international boundary] to Icy Cape (Elliot, 1901:89); [Arctic Slope] (Anderson *in* Stefansson, 1913b:510); bars of most of the rivers [mainly in Canning River District] (Leffingwell, 1919:62); along Arctic Coast from Point Hope to an undetermined area east of Point Barrow (Dufresne, 1946:136); [Arctic Slope] (Burt and Grossenheider, 1952:68); (43) head of Colville River (seen by Charles Hummel in June and July of 1950—*fide* J. W. Bee, MS, June 11, 1952); (46) Kuparuk River, 155°00′, 68°30′ (seen by William Steere on July 1, 1952—*fide* J. W. Bee of the same date); (48) Cape Thompson (Howell, 1938:96); [Cape Thompson] to Point Barrow (Bailey and Hendee, 1926:20); (52) within 3 miles of Itivlik Lake and northwesterly along the Ahlasuruk River for approximately 8 miles (many seen between June 19 and July 22, 1954, by Irving and Paneak, 1954:204).

Dicrostonyx groenlandicus rubricatus (Richardson)
Collared Lemming (Kilyagmiutak)

Arvicola rubricatus Richardson, Zool. Beechey's Voyage, p. 7, 1839, type from American side of Bering Strait.

Myodes torquatus, Baird, Report Explorations & Surveys . . . from the Mississippi to the Pacific Ocean, Exec. Doc. No. 91, 33rd Congress, 2nd Session, 8:558, July 14, 1858.

Cuniculus torquatus, Coues and J. A. Allen, Report U. S. Geol. Survey of the Territories, 2:246, 1877. (Also True, 1884:596; Murdock *in* Ray, 1885:102; Turner, 1886:204; Nelson and True *in* Nelson, 1887:233, 278.)

Dicrostonyx torquatus, Miller, N. Amer. Fauna, 12:40, July 23, 1896. (Also Trouessart, 1898-1899:547.)

Dicrostonyx hudsonius alascensis W. Stone, Proc. Acad. Nat. Sci., Philadelphia, p. 37, March 24, 1900, type from Point Barrow, Alaska.

Dicrostonyx hudsonius nelsoni, Elliot, Field Columbian Mus. Publ., Zool. ser., 2:210, 1901. (Also Trouessart, 1904-05:464.)

Dicrostonyx hudsonius, Stone and Cram, American animals, New York, p. 108, 1905.

Dicrostonyx rubricatus, G. M. Allen, Bull. Mus. Comp. Zool., 62:518, February, 1919. (Also Nelson, 1929:146.)

Dicrostonyx nelsoni, Anderson *in* My life with the Eskimo by Vilhjalmur Stefansson, The Macmillan Co., New York, p. 512, 1919.

Dicrostonyx rubricatus rubricatus, Miller, Bull. U.S. Nat. Mus., 128:397, April 29, 1924. (Also Hinton, 1926:151; Bailey and Hendee, 1926:20; Hall, 1929:424; Dufresne, 1946:142; Strecker *et al.*, 1952:479.)

Dicrostonyx groenlandicus rubricatus, Anderson, Mammals and birds of the western Arctic district, in Canada's Western Northland, Ottawa, p. 110, July 9, 1937. (Also Anderson and Rand, 1945:304; Anderson, 1947:149; Rausch, 1950a:166; 1950c:466; 1951:181; Barkalow, 1952:199; Hall and Cockrum, 1953:482.)

D[icrostonyx]. t[orquatus]. rubricatus, Ognev, The mammals of Russia (U.S.S.R.) and adjacent countries, Publ. Acad. Sci. U.S.S.R., 6:479, 508, 1948. Ognev considers *D. groenlandicus* as conspecific with the earlier named *D. torquatus* Pallas, 1779.

Dicrostonyx groenlandicus, Burt and Grossenheider, A field guide to the mammals, Houghton Mifflin Company, Boston, p. 117, 1952.

Dicrostonyx torquatus rubricatus, Rausch, Arctic, 6:127, prior to October 2, 1953.

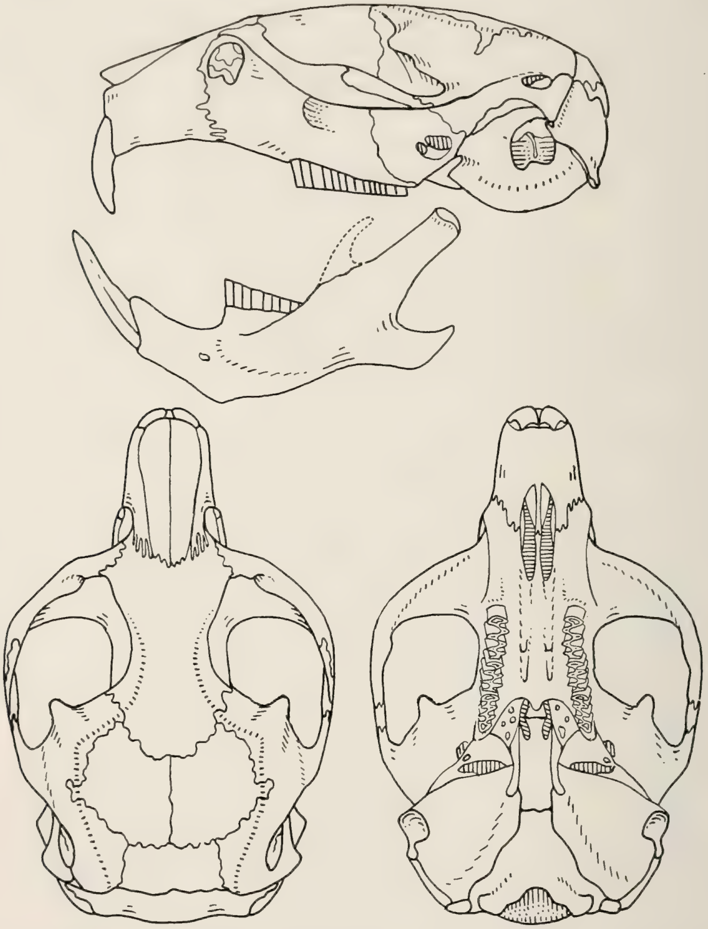


Fig. 15. Skull of *Dicrostonyx groenlandicus rubricatus,* Kaolak River, 159°47′40″, 70°11′15″, 3z ft., July 14, 1951, No. 43324 KU, ♂. × 2½.

Description.—See colored frontispiece. The measurements (all of adults) of seven males and seven females from Barrow Village (Point Barrow), one male and one female from Barter Island, three males from Meade River 50½ mi. S and 9 mi. W Point Barrow, one male from Wahoo Lake and 1 female from Kaolak are, respectively, as follows: Total length, ♂ —, ♀ —, ♂ 138,

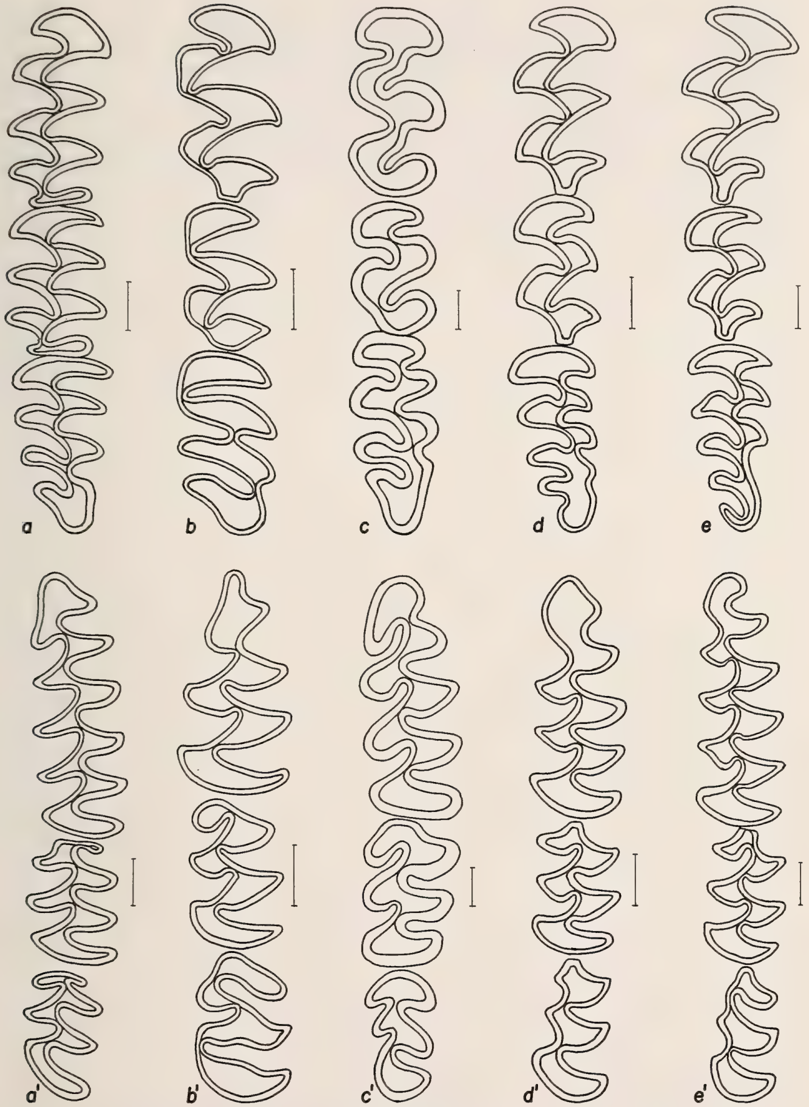


FIG. 16. Enamel patterns of occlusal surfaces of left upper teeth (above) and left lower teeth (below) of five species of microtine rodents. Actual length shown by line to right of each pattern.

a, a'. *Dicrostonyx groenlandicus rubricatus,* Kaolak River, ♂, No. 43324 KU.
b, b'. *Lemmus trimucronatus alascensis,* Birnirk Mounds, ♂, No. 50601 KU.
c, c'. *Clethrionomys rutilus dawsoni,* Mt. Mary, S end Lake Peters, 145°10′02″, 69°20′30″, ♂, No. 51024 KU.
d, d'. *Microtus oeconomus gilmorei,* 9/10 mi. W and 9/10 mi. N Umiat, ♀, No. 51356 KU.
e, e'. *Microtus miurus muriei,* same locality as *M.o. gilmorei* above, ♀, No. 51065 KU.

♀ 158, ♂ 138 (132-147), ♂ 124, ♀ 119; tail, ______, ______, 18, 18, 19 (19-20), 17, 18; hind foot, ______, ______, 20, 20, 19.2 (19-19.5), 18, 17; condylobasal length, 28.0 (27.0-28.8), 28.2 (27.0-29.4), 30.4, 32.0, 29.6 (28.5-30.8), 27.7, 28.0; occipitonasal length, 27.0 (26.7-28.0), 27.6 (26.8-29.4), 29.6, 31.0, 29.3 (28.5-30.8), 27.5, 27.4; nasal length, 8.2 (7.8-8.8), 8.5 (8.1-8.6), 9.2, 9.9, 9.0 (8.5-9.5), 8.4, 8.3; zygomatic breadth, 18.4 (17.5-20), 19.0 (17.7-19.8), 20.4, 20.8, 19.8 (18.8-20.7), 17.7, 18.8; interorbital breadth, 4.0 (3.8-4.3), 4.1 (3.8-4.4), 4.4, 4.1, 4.2, (4.0-4.4), 3.7, 4.1; alveolar length of upper molar series, 7.4 (7.1-7.8), 7.7 (7.1-8.0), 7.9, 8.3, 8.2 (7.8-8.6), 7.6, 7.4; width of rostrum, 4.3, 4.6 (4.5-4.7), 5.0, 5.0, 4.2 (4.0-4.4), 4.1, 4.4; palatilar length, 14.7 (14.2-15.2), 14.6 (13.6-15.1), 15.8, 16.1, 15.4 (14.7-15.9), 14.3, 14.3; width auditory bullae, 14.2 (13.7-14.9), 14.7 (14.1-15.1), 15.9, 15.2, 15.4 (14.4-16.4), 13.7, 14.4; mastoid breadth, 13.8 (13.2-14.5), 14.1 (13.7-15.1), 15.2, 14.9, 14.8 (14.4-15.4), 13.3, 13.9; age index (depth of skull, from top of frontal tubercle, perpendicular to a plane touching each of the tympanic bullae and each of the last (3rd) upper molars), 99 (98-100), 98 (97-100), 103, 101, 98.3 (93.4-102.6), 103, 98; width of skull from medial edges of supratympanic fenestrae, 10.2, 10.5 (10.3-11.3), 10.6, 11.3, 11.0 (10.3-11.8), 9.4, 10.7; weight in grams, ______, ______, 66.9, 66.5, 65 (55-73), 50,

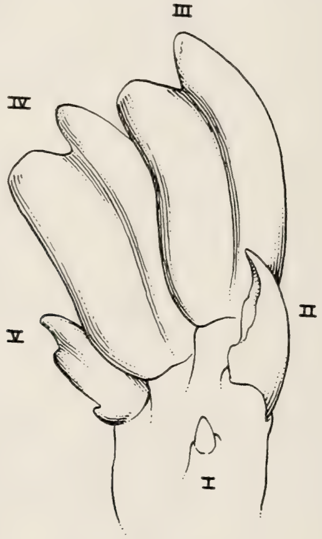


FIG. 17. Palmar view of right forefoot, of *Dicrostonyx g. rubricatus*, showing enlargement of the claws, ♂, 52524 KU, Point Barrow, April 19, 1953. × 4½.

23. In summer pelage, brilliantly colored, sides of muzzle and area about each eye gray (owing to mixture of black-tipped hairs and short white-tipped hairs); forehead from nose to nape black, in most specimens grizzled with few white hairs; this dark mark continuing as narrow median stripe in most specimens to root of tail; each ear marked by patch of rusty hairs; postauricular area whitish producing collar-effect; shoulders nearly clear Chestnut, this color extending posteriorly on sides and blending with mixed blackish, whitish and Chestnut of back; hips grayish; underparts washed with cinnamon; feet and terminal brush of tail whitish. Juveniles with prominent narrow mid-dorsal black stripe, remainder of upper parts brown (between Saccardo's Umber and Sepia); underparts with wash of Sudan Brown but plumbeous more promi-

nent. Young more nearly like adults but grayer and upper parts less mottled. In winter, white; back occasionally incompletely white, some specimens with yellow stain on posterior parts of sides. In summer, hair on body of three types, guard hair, cover hair, and underfur. On back, each of two last-mentioned types of hair with basal half, or more, gray; succeeded by bands of white, yellow, brown, and black tip (see fig. 20). Ears entirely concealed in fur; footsoles densely haired; white animals with foreclaws of digits three and four each with bulbous ventral part as large as dorsal part and separated from dorsal part by lateral groove and by notch at end (see fig. 17); ventral part absent in summer. Skull with squamosal pegs projecting anteriorly behind orbits; first lower molar with seven closed triangles between terminal loops; a total of 39 to 41 closed triangles and or loops in the six molar teeth.

Remarks.—A total of 48 specimens was examined. In this series, specimens of the same age and sex are largest on the flat Coastal Plain, smallest in the Brooks Range, and intermediate in size on the Plateau Province. A specimen with an age factor of 105 from Anaktuvuk Pass in the Brooks Range is relatively small in comparison with comparable specimens from the Coastal Plain. The width of the cranium between the medial edges of the supratympanic fenestrae is considerably less than in animals from the lower Coastal Plain. An average of the measurements of five specimens from Gavia Lake, Wahoo Lake and Porcupine Lake is 9.6 mm instead of 10.7 as in specimens from the Coastal Plain. From the Brooks Range there are also three young specimens (one from Wahoo Lake and two from Porcupine Lake). Each of these is smaller than individuals of the same age from the Coastal Plain. These three individuals from the Brooks Range have acquired the subadult pelage, or substantial parts of it. If comparison be made of them with specimens of the same size from the Coastal Plain (Teshekpuk Lake, Point Barrow and Kaolak) it is seen that the coastal animals have the juvenal pelage and that their skulls also show that they are younger than animals from the mountains.

If the decision to apply the subspecific name *rubricatus* to the population along the Arctic Coast is correct, the application of this same name to populations in the Brooks Range can be considered as tentative. This is because the animals in the Brooks Range are significantly smaller than those farther north. Possibly these small montane animals are an unnamed subspecies, or they may be referable to the subspecies of small animals from along the Bering Sea Coast of Alaska for which Handley (1953:200) uses the name *Dicrostonyx groenlandicus nelsoni* Merriam. We lack material of *D. g. nelsoni* such as would be required to identify with certainty as to subspecies the *Dicrostonyx* from the Brooks Range.

The name-combination *Dicrostonyx torquatus rubricatus* used by Ognev in 1948 and by Rausch in 1953 (see under synonymy at the beginning of this account) may well be correct but neither author has presented proof that the collared lemmings of Eurasia and North America are conspecific. "Proof," to us, would involve publishing the data showing that the degree of difference between the two subspecies of collared lemming on the two sides of Bering Strait (or on the Alaska Peninsula and on the Kamchatka Peninsula)is no greater than the maximum degree of difference that exists between any two subspecies that actually do intergrade with each other on the mainland—either in Asia or in North America. Our reasoning is that if the degree of difference between the two kinds separated by Bering Strait was no more than that between the intergrading pair of subspecies on the mainland, the two subspecies on opposite sides of the Strait would be expected to crossbreed freely if a land connection were re-established that would bring populations of the two kinds together (into contact), and that because of such crossbreeding in nature (= intergradation) the two kinds would be arranged nomenclaturally as subspecies of a single species since intergradation is the criterion of subspecies in mainland mammals. If, instead, the degree of difference between the two kinds separated only by Bering Strait was more than that between any intergrading pair of mainland subspecies, the two kinds on opposite sides of the Strait would be expected not to crossbreed freely if a land connection were re-established that would bring the two kinds into contact, and that because of such non-crossing in nature (lack of intergradation) the kinds would be arranged nomenclaturally as two species since lack of intergradation is the criterion of species in mainland mammals.

The collared lemming occurs throughout the Arctic Slope from the coastline of the Arctic Ocean to altitudes in the Brooks Range as high as there is proper vegetation for existence, but seems never to be so common as the brown lemming.

The collared lemming is most commonly found on the extensive expanses of undulating uplands on the Plateau Province or on the relatively flat or gently sloping ridges between the lowland marshes on the Coastal Plain. In the Brooks Range, the type of physiography in which the collared lemming is best suited to live, is limited in extent. Fracture systems on the surface of the ground are used as runways. Other surface irregularities, which give partial overhead protection are also frequented.

Of the microtines, the collared lemming is best adapted to the freezing temperatures, snow and ice of the winter climate. The enlarged claws on the forefeet and the long white pelage are adaptations to winter. Collared lemmings are most active on cloudy, windless nights but have been trapped at various times in the 24 hour period.

The collared lemming (*Dicrostonyx*) is so closely associated with the cotton-grass (*Eriophorum*) as to justify employing the name *Eriophorum-Dicrostonyx* Association. This association approaches the climax condition on the Arctic Slope. The collared lemming has been taken also at contacts between the grasses and sedges of the lowlands and the vegetation of the upland tundra especially in early seral stages where willows are distributed among mosses, lichens and grasses. At Teshekpuk Lake, collared lemmings were associated with *Eriophorum* as the dominant plant with *Arctogrostis latifolia* (R. Br.) Griseb., *Hierochloe alpina* (Swartz) Roem. and Schult., *Festuca ovina* var. *brachyphylla* (Schult.) Piper, *Trisetum spicatum* (L.) Richt., *Carex misandra* R. Br. and mosses as subdominant.

Two of the subdominant grasses, *Arctogrostis latifolia* (R. Br.) Griseb., and *Poa arctica* R. Br., and two sedges, *Carex lugens* Holm, and *Carex aquatilis* Wahl., were most commonly associated with the dominant sedge *Eriophorum*, at Kaolak on July 26, 1951.

The collared lemming is more nearly restricted to one community than any of the other microtines, and has fewer small-mammal associates. The brown lemming is the principal small mammal trapped with the collared lemming, and mainly at the edge of the marginal limits of the association occupied by the former. When brown lemmings are abundant they enter the periphery of the community used by the collared lemming or even overrun small areas of it. The collared lemming is associated with all of the major influent mammals, especially the caribou, which in certain areas controls the lemming population. The Alaska longspur has been trapped more frequently from the community used by the collared lemming than has any other bird.

In summer the inflorescence of the cotton-grass is kept in motion by winds and whitens the landscape almost as much as a new fallen snow. The observer wonders why, as a protection from overhead predation, the collared lemming does not retain its white fur even in summer.

Individuals, from the Arctic Slope, held captive at the University of Kansas from February 18, 1953, to August 28, 1953, ate several foods, which in decreasing order of preference, were as follows:

lettuce, green leaves of dandelion, green grass, carrots, cereals, apples, dry grasses, and commercial animal foods. Before eating green tops of carrots, the collared lemming cuts off all of their leaves at their bases. In captivity a collared lemming consumes only half as much food as does a brown lemming and eats, in addition to grasses and sedges, a large amount of fruit, tubers and leaves and bark of shrubs, whereas the brown lemming eats principally grasses and sedges.

One collared lemming was the only mammal taken from a line of 145 traps spaced 10 meters apart in a community used by the collared lemming at Topagaruk on July 7, 1951. This animal was trapped in an exposed fracture fissure partly filled with dead leaves at the contact between the upland tundra and an area of hummocks surrounded by drainage channels from two to four feet deep. The contact zone supported a larger number of nesting birds than did adjacent areas.

Although most of the collared lemmings that we trapped were associated with cotton-grass, some were trapped at contacts between upland tundra and lowland communities used by the brown lemming and other microtines. At Kaolak on July 23, 1951, a collared lemming was trapped at the contact between a marsh and a slope of cotton-grass, in a used runway approximately one-third of a meter from a hole in a clump of cotton-grass. One trail led down to the grasses and carices along the water and the other to the slope of cotton-grass. Trapping in this runway for several nights yielded no lemmings of either species. Another collared lemming from Teshekpuk Lake was trapped from an old runway in a protected swale of cotton-grass and willow. This swale had been used previously, when the population of brown lemmings was at a high point. At Wahoo Lake on July 8, a collared lemming was trapped from cotton-grass and dwarf willow near the edge of a damp swale which penetrated the cotton-grass community. Ten traps were set in a grid fashion and left for three days in the vain hope of capturing another collared lemming. Under conditions similar to those at Wahoo Lake, two were trapped at Porcupine Lake on July 14 only 28 meters from traps which caught brown lemmings, singing voles, red-backed voles and tundra voles. Additional traps were set around those which held the collared lemming but without results. At Gavia Lake on August 22, a collared lemming was trapped in dry cotton-grass only a few centimeters high and 33 meters from a trap that caught a tundra vole. It was concluded that the collared lemming lived principally among the hummocks of cotton-grass on the uplands and that those individuals which were trapped with other microtines were from the contacts between the communities used by the collared lemming and the communities used by other microtines.

Arctic foxes at Teshekpuk Lake on July 30 were digging out the nests of the collared lemming and brown lemming. One nest of a collared lemming was excavated by a fox from under five inches of moss.

The snowy owl, Pomarine jaeger, parasitic jaeger, long-tailed jaeger, and the short-eared owl frequently hunt in the community used by the collared lemming.

Two females, from the Arctic Slope, were observed as captives at the University of Kansas. They defended themselves by facing the observer. From this position they chattered continually and 'fought back' with their front feet. Sometimes they shifted the skin of the back so that the black line which is normally along the center of the back was displaced approximately 15 millimeters onto the side toward the observer. When these two captives were placed together in a small cage they approached each other until their noses were about eight millimeters apart. They remained in this position for about 14 seconds before fighting. Action for the first few seconds of the fight was too rapid to be followed until each animal secured a hold on the rump of its opponent. Maintaining their holds, with venters opposite, the two rolled around in the cage. They were separated only by forcefully prying them apart. The second time the two were placed in the same cage they jumped at each other when about 20 centimeters apart. They obtained holds as in the first encounter. When separated they fluffed their fur and walked with short steps. Ordinarily they could be handled safely but the observer was bitten on several occasions; the animal sometimes would jump from a distance of 10 centimeters and bite into the tip of a finger. After a hold was secured, the lemming gradually forced its teeth deeper into the flesh. The hold could be broken only by prying apart the jaws.

Neither of the two captives could be conditioned to remain in an exposed situation. When placed in sunlight on a 40 x 80 millimeter platform elevated 200 millimeters above the ground, the lemming repeatedly dropped to the ground regardless of the consequence suffered from the impact of the fall. When leaving the top of the pedestal, either lemming always jumped into the shadows on the ground. If placed in a sunlit enclosure open at the top the lemming remained at the edge of the enclosure and would not go out into the center. When a small layer of grass was placed in the bottom of the enclosure the lemming immediately burrowed under the grass. It was clear that these animals were conditioned to using burrows and overhead protection.

The collared lemming does not use runways or organize shelters as much as the brown lemming does. Runways made by the brown lemming in times of high population are extended a short distance into the community used by the collared lemming and frequently are used by the collared lemming.

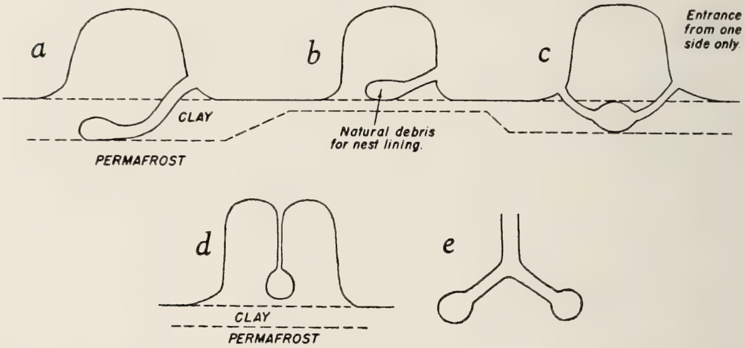


Fig. 18. Nests of *Dicrostonyx g. rubricatus* from several localities on the Arctic Slope of northern Alaska. 1/16 natural size. *a-c*. Burrows and nests, in profile, in hummocks supporting cotton-grass. *d*. Nest between two hummocks. *e*. Horizontal section of a fifth (a double) nest and burrow.

The nests of the collared lemming vary considerably (fig. 18). The permafrost during July is approximately 250 millimeters below the surface. Some nests are in the clay below the moss and cotton-grass layer or in fissures in the ice. These nests are unlined whereas those on the surface of the ground are either sparsely lined with dry grasses or are in the accumulation of debris at the base of a hummock.

At Teshekpuk Lake on July 30, a collared lemming was trapped near its nest which held five fecal pellets and 13 pieces of green grass about 40 millimeters long. This nest seemed to be used for feeding or storage. Another nest had 12 mouthfuls of hair of this same species in the sparse lining of dry grasses. At Kaolak a brown lemming was taken from a burrow made by a collared lemming but no longer used by it.

Daniel Thompson states that the collared lemming makes more extensive burrows than does the brown lemming. In a sandy mound he found extensive tunnels of the collared lemming. One nest that he examined was made of the stems of *Carex*; other nests were made of other plant material. The female lemming probably makes a new nest for each of her broods. A nest used by one brood becomes heavily infested with mites, which could seriously affect a second brood reared there.

Each of our two captives at the University of Kansas made nests within masses of grass placed in the cages and did not organize the nest material. In order to inspect conditions outside, the lemming quickly thrust its head through the top or side of the nest or jumped through the nest wall. If a head of lettuce were placed in an established runway along the side of the cage, the lemming ate a corridor through the lettuce instead of going around it. Fecal pellets were deposited near the edge of the nest chamber or in corners of the cage.

Unlike the brown lemming, the collared lemming rarely if ever destroys its overhead cover of plants. In grazing, it prunes away principally the stems of cotton-grass that grow from the base or sides of a hummock, and ordinarily the central cluster of stems on top of the hummock remains. The brown lemming, on the contrary, usually does not live in areas of hummocks.

On the Arctic Slope of Alaska, fluctuation in numbers of the population of the collared lemming seems to occur less often and to be of lesser degree than in the brown lemming. For the brown lemming, the elimination of the vegetation that provides overhead protection is one of the principal factors causing a decline in numbers, whereas with the collared lemming the natural recesses between the individual hummocks of cotton-grass always give some protection; its grazing habits leave the central parts of plants for overhead protection.

In a transect, one meter wide and 1000 meters long, on the gently rolling tundra above the river valley at our camp on the Kaolak River on July 17, 1951, a census was made of fecal piles at the entrances of burrows used in a previous winter by the collared lemming when it seemingly was abundant. The plant community consisted principally of one dominant sedge (*Eriophorum*), which was uniformly distributed throughout the transect. Several mosses and lichens were associated with the *Eriophorum*. There were 154 fecal piles (averaging 300 pellets per pile with a maximum of 890 pellets) or one per 6.5 square meters of tundra. The distance between any one pile and the nest varied from one to 17 meters and averaged 6.6 meters. The collared lemmings seems to have been essentially solitary even at a time of high population. Fecal pellets not at burrow-entrances were counted, down the center of the transect, in quadrats 10 centimeters square between clumps of cotton-grass. The center of each quadrat was two meters from the next. There were 20 (0-130) fecal pellets per quadrat. Only one quadrat of the 110 lacked pellets. The pellets, all deposited in some previous year, were brown. No fresh sign was seen, but on almost every square inch of this upland tundra there was sign of the former presence of the collared lemming. At Kaolak River a transect was made from the upland tundra down to the edge of the river and the fecal piles that were associated with burrows used by collared lemming were counted in an area 150 meters long and one meter wide. The first 40 meters among cotton-grass of the upland tundra yielded six piles. The next 40 meters, on the slope which supported short grasses and dwarf willow 300 millimeters high and surface nests of the brown lemming, yielded six fecal piles, and the last 70 meters of grasses and dwarf willow from the base of the hill across the valley floor to the edge of the river yielded no fecal piles (only surface nests of the brown lemming). On the upland tundra, sign was least abundant in damp situations between the hummocks of cotton-grass or where green mosses grew between the hummocks and where the hummocks were flattened having other types of vegetation mixed with cotton-grass.

Two quadrats, of the type laid out at Kaolak River to determine the number of fecal deposits, were established for comparative purposes 22 miles distant at Kaolak itself on July 26, 1951, and along the northeast shore of Teshekpuk Lake. At Kaolak in a typical upland community of cotton-grass there were 117 fecal piles in 1000 × 1 meter quadrat or 1 per 8.5 square meters. The distance between fecal piles averaged 8.4 (1-27) meters. At Teshekpuk Lake on July 31, 1951, there were only eight fecal piles in a quadrat 1000 × 1 meters in an upland community of cotton-grass or an average of 1 per 125 square meters of tundra. If a comparison is made between the quadrats of the three areas tested, it will be seen that there is no significant difference between those at Kaolak and at the Kaolak River camp 22 miles distant whereas at Teshekpuk Lake, approximately 160 miles distant on the low Coastal Plain, the differences are significant. The latter area was more trampled by caribou than the other two. Caribou may have kept the lemming at a low population at Teshekpuk Lake. Because of the absence of caribou herds in the immediate vicinity of Barrow Village, lemmings may be able to maintain high populations there. The Alaskan longspurs were commonly trapped in the Kaolak quadrat and Kaolak River quadrat whereas at Teshekpuk Lake they were rarely trapped, possibly because the last mentioned area was trampled at intervals by caribou.

At Kaolak River, pellets of the snowy owl were collected on the transect used for the census of the fecal piles previously described. These pellets were collected in the upland tundra community used by the collared lemming, but the owls probably hunted also in the nearby valley of the Kaolak (Kuk) River. The pellets contained 70 per cent collared lemming (all adults) and 30 per cent brown lemming (all adults). In millimeters, the zygomatic breadth in the largest collared lemming was 18.7 and the smallest 17.4. The largest brown lemming measured 18.7 and the smallest 17.6. The largest number of mammal skulls found in one pellet was three and they were of collared lemming. At Kaolak, 21 snowy owl pellets were taken in an *Eriophorum-Dicrostonyx* Association; this number per unit area compared favorably with the number in the Kaolak River transect. The pellets yielded 72 per cent collared lemming and 28 per cent brown lemming. The largest and smallest collared lemming measured 19.8 and 18.6 in zygomatic breadth and all were adults. The zygomatic breadths of the largest and smallest of these brown lemmings are 23.1 and 22.1.

The brown lemmings were all adults (smallest animal with condylobasal length of 32 mm). This high percentage of the collared lemming in the Kaolak and Kaolak River area indicates a relatively high population of the collared lemming and a low population of the brown lemming for the period preceding 1951. Judging by the age of the lemmings, it seems that they were taken in winter or early spring. Of lemmings trapped in July, 1951, at Kaolak and Kaolak River, 89 per cent were brown lemmings and 11 per cent were collared lemmings.

Fifty-four snowy-owl pellets (averaging 4.4 grams [dry] per pellet) were taken in a community used by the collared lemming at Teshekpuk Lake and were deposited prior to 1951. Contents were 51 brown lemmings, 13 collared lemmings, 5 birds, 1 Arctic fox (radius-ulna, hair and parts of the hide). In zygomatic breadth the largest and smallest collared lemming and brown lemming were, respectively 20.5, 16.0; 22.0, 17.0. At this lake, in 4800 trap-nights between July 29 and August 3, one brown lemming and one collared lemming were trapped. The smaller percentage of collared lemmings from Teshekpuk Lake, than at Kaolak and at Kaolak River, can be explained by unfavorable effect on the collared lemming by trampling of the plant community by caribou, by large percentage of the community of the brown lemming in the forage area of the snowy owls, or by different stages in the population cycles of the lemmings at the time when the pellets were deposited. Because young lemmings were taken by the owls it is assumed that the lemmings were taken in late autumn.

Individual fecal pellets of the collared lemmings measure three to four millimeters long and are deposited in groups of four to 15. Fecal pellets of the brown lemming are larger and are deposited singly, not in groups.

Pelage

We have insufficient material from the Arctic Slope properly to analyze the complete change in pelage in the collared lemming, particularly from juvenal to post-juvenal pelage and early spring-adult pelage; however, we have made some observations that may be noteworthy.

According to W. Stone (1900:38-39) and J. A. Allen (1919:521-522), the collared lemming has completed its winter pelage by October and is in full summer pelage by the first week in June. Specimens collected by us from various localities on the Arctic Slope between June 15, and September 4, 1953, are all in summer pelage. Specimens from Point Barrow, on loan from the Museum of Vertebrate Zoology at Berkeley, California, show full winter pelages for the months of February, March and April. In addition to the regular juvenal, post-juvenal, adult, spring, and autumn pelage-changes there is a second winter pelage, which is demonstrated in several specimens from Point Barrow. These specimens (see fig. 19, *c* and *d*) show a progressive molt-line of white hair beneath the original white winter coat acquired in the autumn. Several specimens show brown pelage on the back and head, which under ordinary circumstances would be interpreted as the beginning of new summer hair but which in fact is part of the winter pelage—a part that did not come in white. This brown hair perhaps results from a genetic factor, which, during an earlier period of the Pleistocene was responsible for a dark winter pelage.

A yellowish stain on the pelage of the posterior parts of the sides may result from the action of secretions from the glands on the flanks or from unsanitary conditions of the subterranean burrows.

The sequence of change in the pelage resembles that in the

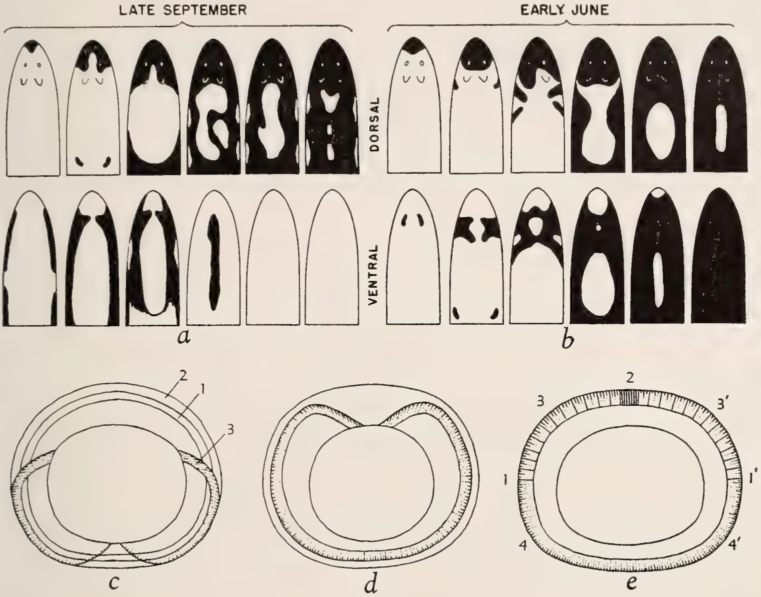


FIG. 19. *a-e*. Sequence of changes in pelage of adults of *Dicrostonyx g. rubricatus* from Point Barrow, Alaska, showing changes from summer to winter and from winter to summer.

a. Dorsal aspect of body (above) and ventral aspect (below) showing change from summer pelage to winter pelage.

b. Dorsal aspect of body (above) and ventral aspect (below) showing change from winter pelage to summer pelage. In both *a*. and *b*. black areas represent growing hair; for any given specimen of which the dorsal aspect is shown, the ventral aspect of the same specimen is shown directly below.

c. Cross-section of an adult (40122 MVZ) taken in March, 1928, showing incoming hair of second winter coat. 1. summer or winter juvenal pelage (brown); 2. first white winter pelage; 3. second white winter pelage.

d. Cross-section of an adult (40119 MVZ) taken on February 4, 1928, in first winter pelage with second winter pelage nearing completion and of same color as first winter pelage. This second winter pelage grows in animals changing from post-juveniles to adults during the winter as well as in animals that are in the adult summer pelage at the beginning of winter.

e. Distribution of black guard hairs on back and sides. 1. lateral boundary of black guard hairs; 2. mid-dorsal black line; 3. 3′ 4, 4′, principal growth centers.

brown lemming. The change from post-juvenal to adult is regular. It begins in a line low down on each side and progresses dorsally and ventrally. The irregular pattern of change in older adults results from a combination of the process just described in younger animals and a spreading downward of new pelage from accessory centers of hair-growth on the back or high on the sides.

In adult collared lemmings the long, black guard hairs occur in a definite area on the back, not on the sides or underparts, and are arranged precisely as in the brown lemming (see fig. 36). The area of transition from the black guard hairs to the area of long, buff and chestnut hairs on the sides is narrow—only as wide as the area occupied by the roots of three or four hairs. In this area of transition the distal third of some of the guard hairs is black and then yellow to the tip and others have alternating black and yellow bands instead of having the distal third all of one color which is characteristic of the other guard hairs. Beyond (ventral to) the area of transition, there are no guard hairs, but the distal third of the cover hairs there are white and then yellow or buff distally to the tip.

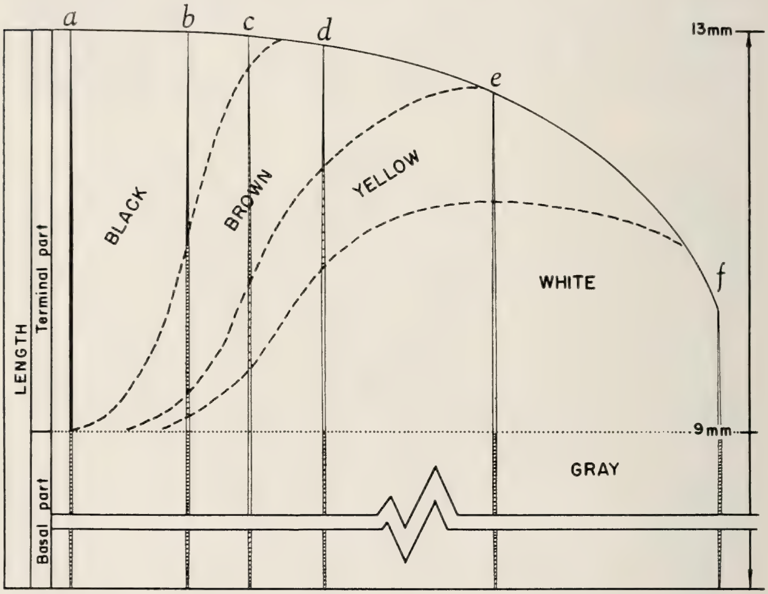


Fig. 20. Types of banding of hair, in summer, from the back of *Dicrostonyx g. rubricatus* from Point Barrow showing possible combinations of colored pigments and length of individual hairs. *a-f.* Individual hairs.

Three measurements were taken of the longest hairs from each of three regions on the animal. The measurements were: 1) gray basal part of hair, 2) gray basal part plus the colored terminal part, and 3) over-all length of the hair. On hair from the back (half way between nose and tail but 5 mm from the mid-dorsal line), the three measurements were, respectively: in summer, 9, 13, 15; in winter, 11, 19, 25. Corresponding measurements of hair from the sides, midway of the body, were: in summer, 8, 12, 17; in winter, 10, 18, 26. Corresponding measurements of hair from the rump were: in summer, 9, 11, 17; in winter, 9, 21, 30.

The pelt of the collared lemming adheres to the body muscles by tough connective tissue and is more difficult to remove than the pelt of the other microtines on the Arctic Slope.

Two females, from Point Barrow, held captive in a room with circulating air and with constant temperature of 70°F and natural light from windows at the University of Kansas showed irregularities in molt as follows: February 19, 1953, brown summer pelage (prior to this date these two animals were kept at Anchorage, Alaska, at the Public Health Center where, at that time, they had changed from white to the brown summer pelage); March 18, 1953, beginning of white pelage which was completed on March 31, 1953; June 12, 1953, beginning of brown summer pelage which was completed by June 28, 1953; August 29, 1953, still in brown summer pelage. These animals decreased in weight for eight consecutive days beginning with the first sign of pigmentation and growth of new hair. Because the amount of food consumed was the same before and during the molt, it seems that a considerable amount of energy is expended as a result of physiological processes accompanying molt.

Records of occurrence.—Specimens examined, 48: Nos. 43321-26, 50531-39, 52524, 56537, 59626. (Specimens other than those of the University of Kansas are listed with localities.) (1) Point Barrow, 23 (21 U.S.N.M., Nos. 107739, 107748, 107749, 107751, 107743; skulls alone, Nos. 107741, 107746, 107750, 107752; M.V.Z., No. 40118-40120, 40123, 51583, 66157-66159). (See also Murdock *in* Ray, 1885:102 [Point Barrow]; Nelson and True *in* Nelson, 1887:233, 278; W. Stone, 1900:38; Elliot, 1901:210; Trouessart, 1904-05:464; Miller, 1912b:207; G. M. Allen, 1919:524; Nelson, 1929:146; Hall, 1929:424 [Point Barrow]; Anderson and Rand, 1945:305; Dufresne, 1946:142; Rausch, 1950b: 136; Hall and Cockrum, 1953:484.); (2) Barrow Village, 2 (1 M.V.Z., No. 40122); (3) 5¾ mi. SSW Point Barrow, 1; (5) NE Teshekpuk Lake, 153°05′40″, 70°39′40″, 12 ft., 1; (6) Meade River, 50½ mi. S and 9 mi. W Point Barrow, 156°30′53″, 70°39′30″, 40 ft., 3; (7) Topagaruk, 155°48′, 70°34′, 1; (9) Kaolak River, 159°47′40″, 70°11′15″, 30 ft., 2; (11) Barter Island, 6 (3 North Carolina State College, Nos. 1401, 1402, 1424; 3 Univ. Wisconsin Zool. Mus., Nos. 13978, 13980, 13991) (See also Anderson and Rand, 1945:305; Strecker *et al.*, 1952:479; Barkalow, 1952:199.); (15) Kaolak, 160°14′51″, 69°56′00″, 178 ft., 2; (18) Gavia Lake, N White Hills, 150°00′, 69°35′, 460 ft., 1; (21) Driftwood, 1 (U.S.N.M., skull alone No. 292997); (22) Wahoo Lake, 146°58′, 69°08′, 2350 ft., Brooks Range, 2; (23) Porcupine Lake, 146°29′50″, 68°51′57″, 3140 ft., Brooks Range, 2; (25) Anaktuvuk Pass, 1 (U.S.N.M., No. 290347).

Additional records: (4) [definite localities unspecified]: circumpolar, south to Behring's Straits (Baird, 1858:559); Arctic America (Coues and J. A. Allen, 1877:247; True, 1884:596); north to the extreme Arctic shore of the territory (Nelson and True *in* Nelson, 1887:278; Arctic regions (Miller, 1896:38); barren grounds of Arctic America (Stone and Cram, 1905:109); [along the Arctic Coast to international boundary] (Hinton, 1926:151); Arctic Alaska [definite locality not specified] (Bailey and Hendee, 1926:20); barrens of northern Alaska (Anthony, 1928:403); Northern Alaska Coast, Anderson, 1937:110; Arctic Coast (Dufresne, 1946:142); tundra and unforested regions of northwestern and northern coast of Alaska (Anderson, 1947:149); [Arctic Slope] (Burt and Grossenheider, 1952:118); (8) Wainright (Bailey and Hendee, 1928:21); (10) Flaxman Island (G. M. Allen, 1919:524; Anderson *in* Stefansson, 1913b:512); (12) Griffin Point (G. M. Allen, 1919:524); (13) Collinson Point (Anderson and Rand, 1945:305); (14) Point Humphrey (G. M. Allen, 1919:524; Gilmore, 1933:258); (16) Demarcation Point (G. M. Allen, 1919:524); (17) Arctic Coast south to latitude 60° [definite locality unspecified] (Turner, 1886:204); [Cape Thompson] to Point Barrow [definite locality not specified] (Elliot, 1901:210); (19) Umiat (Rausch, 1950b:136); (20) Lake Schrader (Rausch, 1951:181); (24) Tolugak [=Tulugak] Lake (Rausch, 1950c:466).

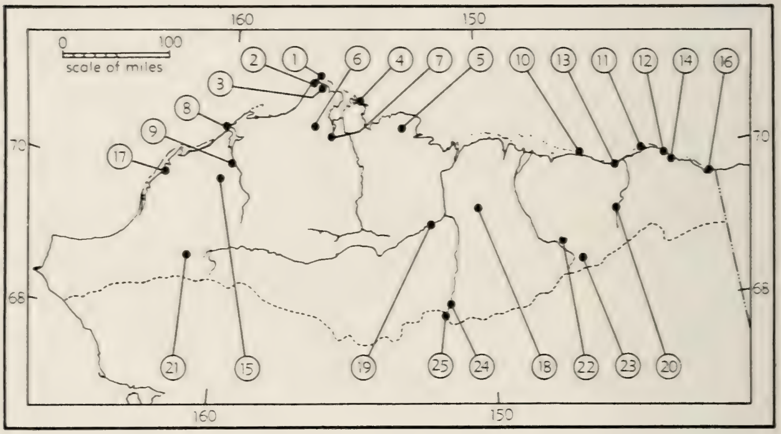


FIG. 21. Record stations of occurrence for *Dicrostonyx groenlandicus rubricatus.*

Lemmus trimucronatus alascensis Merriam
Brown Lemming (Avingapiak)

Lemmus alascensis Merriam, Proc. Washington Acad. Sci., 2:26, March 14, 1900, type from Point Barrow, Alaska. (Also Bailey and Hendee, 1926: 20; Hall, 1929:423.)

? *Myodes albigularis* Wagner, Schreber's Säugethiere, Suppl., p. 602, 1843, according to Hinton 1926:207, may be from the NW coast of North America.

Myodes obensis, True, Proc. U.S. Nat. Mus., 7 (App., Cir. 29): 596, November 29, 1884, part. (Also Murdock *in* Ray, 1885:102; Turner, 1886: 204; Nelson and True *in* Nelson, 1887:233, 277.)

Lemmus obensis trimucronatus, Trouessart, Catalogus mammalium tam viventium quam fossilium, 1:546, 1898-1899.

Lemmus trimucronatus, W. Stone, Proc. Acad. Nat. Sci., Philadelphia, p. 35, March 24, 1900. (Also Anderson *in* Stefansson, 1913b:512.)

Lemmus trimucronatus alascensis, Anderson, Mammals and birds of the Western Arctic District, Northwest Territories, Canada, p. 110 *in* Canada's Western Northland, Dept. Mines and Resources, Ottawa, July 9, 1937. (Also Davis, 1944:21; Dufresne, 1946:141; Rausch, 1950a:166; Hall and Cockrum, 1953:471.)

Lemmus trimucronatus trimucronatus, Davis, The Murrelet, 25(2):20, September 9, 1944, part.

Lemmus sibiricus trimucronatus, Rausch, Arctic, 6:126, prior to October 2, 1953, part. In support of Rausch's name-combination it should be noted that *Lemmus sibiricus chrysogaster* (see Ellerman and Morrison-Scott, Checklist of Palearctic and Indian mammals, 1758-1946, Publ. British Museum (Nat. Hist.), p. 656, November 19, 1951) and *Lemmus trimucronatus alascensis* were considered as conspecific by Ognev, The mammals of Russia (U.S.S.R.) and adjacent countries, Publ. Acad. Sci. U.S.S.R., 6:467, 470, 1948. Ognev used the name-combination *Lemmus obensis chrysogaster* instead of *Lemmus sibiricus chrysogaster* of Ellerman and Morrison-Scott.

Description.—See colored frontispiece. Average and extreme measurements below are in millimeters of 80 adult males and 80 adult females from within a half mile or less of the Arctic Coast between Barrow Village and Point Barrow. Age index 90 degrees or more (for explanation of the index, see under *Remarks* on page 112. All of these adults had molted at least once. Total length, ♂ 151 (132-168), ♀ 145(133-161); tail, 20.9(16-26), 20.8(17-25); hind foot, 20.6(18-23), 20.3(19-22); ear, 9.8(9-13), 9.7(8-11); condylobasal length, 32.2(29.3-35.8), 31.3(29.2-33.5); occipitonasal length, 32.1(29.7-35.6), 31.0(29.4-33.2); length of nasals, 9.4(8.1-10.7), 9.1(8.3-10.5); zygomatic breadth, 21.5(18.9-23.7), 21.1(18.8-23.1); interorbital breadth, 3.8(3.3-4.2), 3.8(3.0-4.3); alveolar length of maxillary tooth-row, 8.9(8.3-9.8), 9.0(8.4-9.8); width of rostrum, 5.4(4.9-6.0), 5.1(4.6-5.7); palatilar length, 17.0(15.1-18.8), 16.6(15.2-17.7); mastoid breadth, 15.8(14.5-17.2), 15.6(14.5-16.6); palatofrontal depth, 8.8(7.6-10.1), 8.5(7.5-9.7); diastema, 10.2(8.9-11.5), 9.8 (8.9-11.0); alveolar length of tooth-row expressed as a percentage of length of diastema, 87(80-97), 91.7(80-100); width of nasals, 4.1(3.3-5.0), 3.9 (3.3-4.5); width of braincase between supratympanic fenestrae, 10.4(9.4-11.5), 10.4(9.5-11.4); index of width of braincase (width divided by condylobasal length × 100), 31.0(28.0-36.8), 30.3(27.2-34.6); weight, 78.3(48-113), 67.8(41-105); age index (see figure 40 on page 111), 96.3° (90°-101.5°), 95.3°(91°-99°). Early juvenal pelage with short hair (♂ 50629, September 9): Back anteriorly Clay Color, rump near (*j*) Tawny-Olive, sides near (*c*) Pinkish Buff, underparts Pale Olive-Buff. Full juvenal pelage (♂ 50748, September 8): Back anteriorly near (*n*) Mummy Brown, rump like back anteriorly but with more buff, sides like back but grayer, underparts Light Buff with grayish black of underfur showing through. Full post-juvenal pelage like breeding preadult but more grizzled. Breeding pre-adult (♀ 50801, June 18), head and anterior part of back Saccardo's Umber with admixture of black producing a lined and grizzled effect, rump near (*10'l*) Chestnut Brown, sides near (*a*) Cinnamon-Buff, underparts near (*c*) Pinkish Buff with admixture of black.

Spring-adult (♂ 50819, June 19) with anterior back and head near (*l*) Dresden Brown, rump near (10′*l*) Chestnut Brown (some specimens with a shade of near (10′) Chestnut Brown), sides Ochraceous-Tawny, underparts near (*a*) Clay Color. Winter adult (♀ 50552, June 15) with head anterior part of back near (*a*) Saccardo's Umber, rump Dresden Brown, underparts light Pinkish Buff with admixture of black. Worn breeding adult of late summer (♂ 50671, September 4) with head and anterior part of back Mummy Brown, rump near Carob Brown, sides near (*j*) Buckthorn Brown, underparts lighter than sides but showing plumbeous bases of some underhairs.

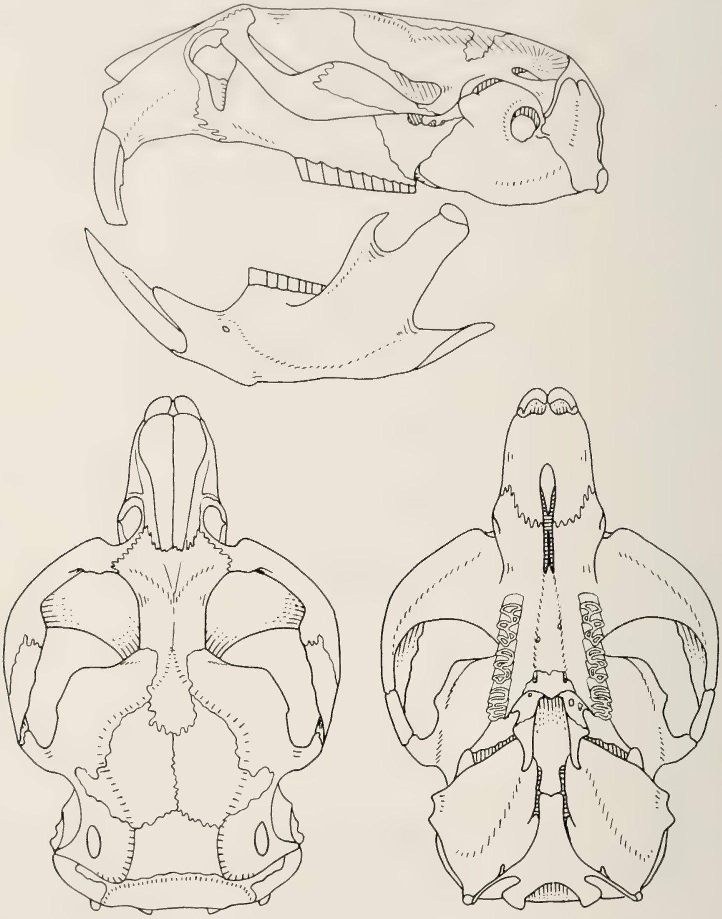


FIG. 22. Skull of *Lemmus trimucronatus alascensis*, 1⅖ mi. S and ⅗ mi. E Barrow Village, 156°45′25″, 71°16′20″, 20 ft., June 20, 1952, No. 50838 KU, ♂. × 2.

Distribution, Relative Abundance and Habitat

The brown lemming occurs throughout the Arctic Slope wherever vegetation, physiography and competition with the other animals permit. The species becomes more numerous from south to north, and at the latitude of Point Barrow attains its greatest abundance.

At Lake Schrader in the Romanzof Mountains there is a segment of an inactive alluvial fan supporting a limited area of permanent soil-polygons. On these the brown lemming was the dominant mammal. On areas adjoining these polygons other voles were dominant and there were fewer lemmings. At Wahoo, Porcupine and Chandler lakes the brown lemming occurs in a variety of situations but none of these is optimum for the species. Low ridges in wet meadows are more often used than any other situations. The highest altitude at which the brown lemming was taken was 3140 feet at Porcupine Lake, but, where vegetation and topography were favorable for the species, it occurred in limited numbers up to at least 5000 feet. At lower elevations of 300 to 400 feet, for example, in the river valleys of the Plateau Province, where gently sloping swales penetrate the undulating upland, the brown lemming is still in competition with the tundra vole and, to some extent, with the collared lemming.

On the low coastal plain and especially to the north, the brown lemming finds conditions optimum for its existence, both in the physiography and in the lack of competition from related microtines. On this plain the lemming occurs on the relatively permanent, well-drained ridges of the soil polygons, at the edges of lakes with irregularities of relief, and on other minor raised areas in wet to damp meadows that are between lakes and ponds. Elsewhere it is less numerous.

The brown lemming seems to be well adapted to the climates of the Arctic Slope. The animal evades the low temperatures of the long winter months by living under the snow. Periods of adjustment that are critical for the lemming occur in spring when water from melting snow inundates much of the habitat and again in autumn when temperatures are dropping and winds are increasing in velocity before snow has fallen. After snow has fallen, the winds, then of average to moderate velocities, are beneficial to some lemmings by covering them with snow and are harmful to some lemmings by blowing the snow away and exposing them. In summer, rain is the single climatic factor that causes the greatest adjustment. One night when it rained we had traps set in a meadow, that was damp to wet. Eighty per cent of the traps were sprung as a result of rain striking the treadles of the traps, 50 per cent were under 25 to 50 millimeters of standing water, 25 per cent were in water not deep enough completely to cover the trap and 25 per cent were above water-level. Some of the lemmings were caught in the inundated area in traps that were in shallow water, but more were caught above the water level and adjacent to the drained areas, suggesting that deeper water had forced some lemmings to move. Permafrost prevents water from seeping into the soil, and water therefore stands in much of the habitat of the lemming. Lemmings are active during rains only to a limited degree. They are most active on cloudy, still nights. The darker the night the farther the lemmings range from their trail systems. In summer, the brown lemming has been taken in every hour of the day and night. On the low Coastal Plain between the Canning River and the Colville River there are large frost-mounds—one to approximately four square miles. The mounds are from two meters to 15 meters high; one was approximately 100 meters long and 15 meters wide. These mounds are conspicuous features of the landscape and may serve as refugia for the brown lemming and other small mammals during periods of exceptionally heavy rains and local flooding.

The plants of the community where the brown lemming lives consists predominantly of sedges and grasses with the herbs, shrubs, mosses and lichens as secondary elements, except as they offer surface protection and nesting sites. The ecological requirements of the brown lemming are precise and it inhabits only certain plant communities in a tundra that at first glance appears homogeneous. The grasses cannot be too wet, too sparse, or too dry and should offer from 25 to 40 centimeters of overhead protection. The lemmings are found in short grasses during the periods of high population when they are forced to occupy marginal situations. The luxuriant grasses associated with the fertile soils of abandoned Eskimo mounds are utilized locally for food and shelter during the periods when the population is low. The brown lemming commonly invades the area where the collared lemming lives by following the damp swales of sedges and wet grasses up into the cotton-grass (Genus *Eriophorum*) on elevated uplands. The collared lemming is the only other microtine that is common in the northern part of the geographic range of the brown lemming.

The number of interrelations between the brown lemming and plants and other animals of its community is limited but those that do occur are intense, particularly those concerned with predation and the periodic destruction of the plant cover.

Sedges and grasses associated with the damper soils constitute most of the food. The tender bases of the grass stems are eaten; most of the blades generally remain and afford overhead protection. In spring when drainage systems are flooded by melting snows, large piles of clipped grass are washed up on the surface of the snow on, and beyond, the creek banks. One such pile measured four by three meters and was one third of a meter high. In 1951, in certain areas at Point Barrow, as the population increased, 100 per cent of the grass associated with trail systems was utilized. Cotton-grass, which is normally associated with the community used by the collared lemming is extensively eaten in the winter. At our camp on the Kaolak River, the lemming had eaten 34 hummocks of cotton-grass (*Eriophorum vaginatum*) in a quadrat 15 x 15 meters in the winter of 1950-51. Here, there was sedge in the swales and cotton-grass on the higher ground. In no instance had the cotton-grass been eaten beyond the sedges and grasses of the swale, which was inhabited by the brown lemming. On one of the Eskimo mounds at Birnirk, *Carex* sp., and *Alopecurus alpinus* J. E. Smith, *Poa* sp. and *Arctophila fulva* were used for food.

In winter in areas where lemmings are numerous, most of the vegetation, except a few mosses and lichens, is eaten. This degree of utilization of the vegetation has a profound impact upon the succession of the plant community.

On July 8 at Topagaruk, there were 13 excavations, made by the Arctic fox in digging out the brown lemming, in an area 30 meters square. The subsurface nest chambers, on mounds from one to one and a half feet high between the high raised polygons and the low flat swales, are most commonly excavated by the Arctic foxes; they have to remove only a shallow layer of vegetation to expose the nest chamber of the lemming. On the stabilized or raised polygons, the subsurface chambers are deep; this makes digging more difficult for the fox and as a result the excavations on these polygons are fewer although the population of lemming is higher there.

In some places on the floors of the canyons of the Brooks Range the trampling by caribou destroys the plants and eliminates nearly all of the brown lemmings. The few small mammals remaining are forced to the plant refugia that have not been affected. Overgrazing by caribou considerably reduces populations of the lemming.

The grizzly, wolf, wolverine and red fox have been seen in the act of extracting brown lemmings from their underground chambers.

The least weasel, more often than the ermine, was associated with communities used by the brown lemming. All three species of shrews have been caught in runways used by the brown lemming.

The tundra vole is in direct competition with the brown lemming especially on the Plateau Province and in the Brooks Range. The lemming comes in contact with the singing vole only secondarily.

Some lemmings, if approached by man, or surprised in an open place, run out into the shallow water where they crouch quietly. If cornered they squeak and defend themselves by means of their front feet. If in a shallow pit, the lemming turns on its back to defend itself. On a few occasions we surprised lemmings sunning themselves, lying on their sides in open places near runways to which the animals immediately retreated when the observer was detected.

The jaegers (*Stercorarius pomarinus, S. parasiticus* and *S. longicaudus*) prey heavily on the lemming. On several occasions a Pomarine jaeger was seen in flight with a lemming in its beak; these birds were observed to capture lemmings by sailing approximately one meter above the ground, or by hovering approximately seven meters above the lemming, and then dropping abruptly, beak first, on the prey. The jaeger grasps the lemming by the back and after a few seconds of repeated squeezing orients the rodent so that is is swallowed tail first. The feet of the jaeger are not used on the lemming. A series of parallel incisions on the back of a lemming are generally made by the jaeger in the killing process. At Point Barrow in June of 1952, in the first year of a period of high population of the lemming, we counted 19 Pomarine jaegers and three parasitic jaegers in 240 acres. The jaegers there were preying on lemmings.

The snowy owl preys extensively on the lemming as do the jaegers. Numerically there are fewer owls than jaegers, but the owls remain longer—perhaps throughout the year—and each owl therefore kills more lemmings than each jaeger. The jaegers are migratory and live elsewhere for most of the year.

Many other birds come in contact with the lemming. An unusual relationship is that of the Alaskan longspur, which occasionally makes its nest in a sunken runway. One such nest containing five fresh eggs was in a fracture fissure used as a runway. The lemmings detoured past the nest. Another nest was within 100 millimeters of runways of the lemming and within 1/3 of a meter of a lemming nest. The snow bunting uses abandoned lemming-holes for nesting. In summer, mosquitoes annoy lemmings considerably especially around the eyes and nose. Under certain conditions, mosquitoes control the activity of the lemming. Some mosquitoes, it is reported, live as adults through the winter in burrows of lemmings.

As early as June 15, flies deposited eggs on dead lemmings in traps.

Along lakes where the edges are being eroded, the brown lemming may contribute to the erosion by excavating burrows and by making deep trails on the steep surfaces. Elevated ridges of soil polygons are similarly affected by the lemming. Organic material—nests and unused plant material—is incorporated into the soils. Fecal droppings, especially deposits accumulated during the winter, contribute to the soils. The feces usually are deposited approximately 130 millimeters to one side of the main trail. A typical accumulation is approximately 60 × 120 × 120 millimeters.

Shelters and Runways

In summer, lemmings use subsurface chambers for protection, for resting and for rearing their young. Chambers used for rearing young are large and lined with dry grass, whereas chambers used for resting and temporary protection are about the size of the animal and are either unlined or have only a few blades of grass on the floor. The depth to which a chamber is excavated depends on the condition of the soil and seemingly on the purpose for which the chamber is to be used. On raised polygons the chambers are as much as two-thirds of a meter below the surface whereas on low relief the chambers are seldom more than 90 millimeters below the surface where they are partly in, or rest on, the permafrost. The average length of burrows that lead from the surface of the ground to the chamber is 220 (50-1000) millimeters. In several instances, corridors, which were made under superficial layers of moss and used as part of the system of surface runways, extended approximately five meters from the mouth of the burrow. A subsurface chamber may, or may not, have an adjoining chamber, which is placed below the active permafrost zone in solid ice of soil fractures. The lemmings retreat to these ice chambers for protection from predators or to keep cool during the hottest part of the summer. A lemming is difficult to extract when it is securely lodged in one of these ice chambers with only a part of the back exposed at the permafrost line. If the ice chamber is large enough, the lemming will turn around, face the intruder and defend itself by using its feet and teeth. In spring and autumn, surface water drains into many chambers and tunnels. This water freezes and makes a pavement of ice in the tunnels.

Dry nests of grasses are made in weathered crania of baleen whales along the coast, or under wooden- and cardboard-boxes and oil drums. The large cavities in the posterior end of rami of the lower jaw of the baleen whale also are used as resting chambers. These cavities contain no vegetation but are partly filled with the fecal pellets of the lemming. In July of 1952 a lemming, which was held in a trap by the hind foot, built a shelter of green grass. We have no other records of surface nests used in summer. On June 22, 1952, in an area 30 x 30 meters, 15 lemmings were found in 45 subsurface chambers.

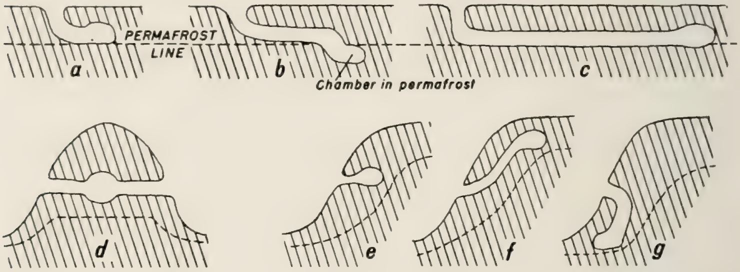


Fig. 23. Cross sections of representative subsurface chambers used by brown lemmings on June 17, 1952, at Point Barrow, Alaska. × 1/14.

a-c are in the low mounds, intermediate between the flat areas of the damp soils where the permafrost controls the depth to which the chambers can be excavated, and the higher raised polygons. *b* shows the ice or permafrost chamber.

d-g are in areas of relief where the chambers are deeper but are still influenced by the permafrost in the mounds. The chambers in the low flat areas are more frequently excavated by foxes and wolves than are other chambers.

In winter, nests of grass are made in chambers in the snow at ground level especially in areas where soils cannot be excavated. These winter nests are in places that, during the summer, would prejudice the survival of the young. The nests are subspherical and vary in the amount of insulation used (see fig. 24). The inner third of the lining of the nest consists of alternating layers of dry grass and fur of the brown lemming whereas the outer two-thirds is coarse grass. Most of the insulation is on the floor and becomes compressed with use. The entrance to the nest is elliptical and high enough on the side of the nest to have an elevated threshold. As the nest continues to be used the animal heat from the lemming melts the snow from the sides and top of the nest and the resulting moisture freezes into a thin layer of ice on the inside surface of the snow chamber. The air space between the nest and the wall of the snow chamber creates an additional layer of insulation. In early spring when the snow begins to melt, the top of the snow chamber which houses the nest collapses and although the nest is exposed it receives protection from the high walls of the side of the snow chamber.

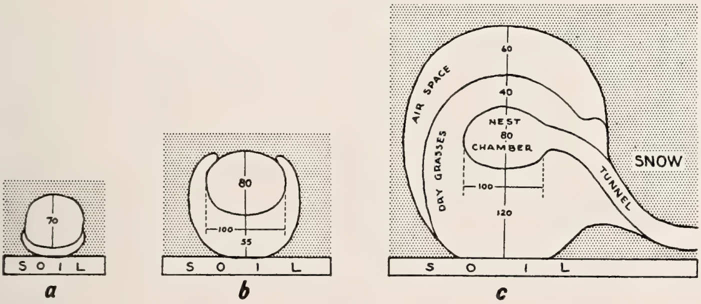


FIG. 24. Cross sections of three winter nests, of the brown lemming, examined on June 17, 1952, at Point Barrow, Alaska. These nests of grass are in snow chambers at the ground level. *a*, *b* and *c* show the relative amount of insulation of grass used in individual nests. In *c* the entrance and the snow chamber are shown. Generally more than two trails lead away from one of these winter nests. Measurements in millimeters. Drawings are to scale.

In some places nests were grouped (5 in an area 1 × 8 meters) and showed progressive degrees of decomposition as if used by successive litters over a period of five years or more. At Teshekpuk Lake on August 3, 1951, we found 98 nests in 1300 linear meters at the contact between an extensive, wet marsh and a slope which was intensively used by caribou. There were no other nests either in the area used by caribou or out in the marsh. Other nests were concentrated on the eroded shores of lakes, some of the concentrations being on north-facing shores.

Cyclic Fluctuations

Fluctuation in the size of the population occurs in periods of three to five years and according to the Eskimos at Barrow Village, these fluctuations have always occurred in the Point Barrow area. The fluctuation is governed by a complex interrelationship between 1) the rate of reproduction, 2) the toll of lemmings taken by predators, and 3) the toll taken by environmental resistance otherwise. Most of the available information is for summer and until we know what takes place beneath the protective covering of snow during the long winter, we can not be certain of the cause of population increase and decline. It seems that the fluctuation results from an increase, in mathematical ratio, owing to freedom from natural checks during the long winter. It seems also that the over utilization of the food supply initiates the final crash.

Crash and Build-up

In the spring of 1949 at Point Barrow, Rausch (1950:166) witnessed the last of the high point in numbers of the lemming and the ensuing crash. During the period between the crash and the early spring of 1951 the population was held to a minimum. In the spring of 1951 between July 6 and July 16 only one brown lemming was trapped by us in 5000 trap-nights from various localities on the Coastal Plain which formerly supported great numbers of lemmings before the crash. At one of these localities there were 75 nests in 655 square meters through which our line of traps was set. Most of these nests were old and they were in varying degrees of decomposition. Between July 16 and September 10 of this same year 58 lemmings were trapped and these were from only the most favorable areas of taller grasses and sedges in marshy places. Trails were lacking and there were no matted clumps of cut-grass. On September 8, 1951, 84 traps set on approximately 180 square meters of 13 old Eskimo mounds at Birnirk caught five lemmings (6 per cent yield). These data suggest that there had been a gradual increase in the lemming population during the latter part of the summer of 1951 of the third year of the cycle.

Winter (1951-1952) of the Third Year of the Cycle

The autumn population of the third year decreased through September and the first part of October. In these months the lemmings were adjusting themselves to the rigors of autumn and early winter. By November there was snow sufficient to give adequate overhead protection and a chance for the animals to extend corridors to food reserves. The winds of high velocity drifted the light fall of snow into swales and low places. The lemmings go to these swales, probably because of the overhead protection there; consequently considerable areas—high areas—that are occupied in summer are deserted in winter. From December to March the monthly, average minimum-temperature ranged from −15 degrees F to −35 degrees F. The combination of low light intensity, low temperature and poor quality of food inhibited breeding; a limited amount of breeding was continued, however, and the population increased because of it and because of a combination of a lack of predation, more stable habitat, and possibly because the confined quarters offered better opportunities for male and female contact. The air temperature increased from −2.2 degrees F in April to 14.2 degrees F in May but had little effect upon ground temperatures. Nevertheless, the increase in the population and the reduced quantity of grass now placed a check on the number of young that could survive and also may have inhibited reproduction. Most of the young subadults were eliminated in the early spring when they were forced to search for new territories because of competition with the older adults. In May there was a decided decrease in reproductive activity which may have been the result of the elimination of the younger animals which were responsible for the breeding during the winter. The first high point in the 'building back' of the population was in the winter of 1951-1952—in the third year after the crash.

Spring (1952) of the Fourth Year of the Cycle

In the latter part of May, 1952, the snow on the ground gave adequate protection to the lemmings and concealed their forage trails but by the first of June temperatures had risen above freezing, at least during part of the day, and the snow started to melt. On June 14, 1952, 80 per cent of the ground surface on the Coastal Plain was covered with snow. Winds, which blew the snow off the high points and drifted it into the depressions, and thawing because of rising temperatures exposed the rest of the surface area. Ninety-nine per cent of the lakes were frozen and sealed around the edges with drifted snow. Some of these frozen lakes, especially in the southern part of the Coastal Plain, were receiving water from creeks. The centers of the polygons and the channels between adjoining polygons were covered with snow whereas the ridges at the edges of the polygons were bare. The part of the Coastal Plain bordering the Arctic Ocean had a deeper cover of snow than the part to the south because much of the snow that falls on the ice of the Arctic Ocean is blown southward onto the land. Lakes in the coastal region were completely covered with this accumulated snow and the contact between the ocean and the mainland was almost indistinguishable.

Eighty-five per cent of the area at Birnirk was still under a covering of snow on June 14. The Eskimo mounds which were refugia for the lemmings during the period of their low numbers appeared much as they would in winter with only their tops showing. In some areas between the mounds, the snow had melted and uncovered runways and nests that had been used during the winter but that, on June 14, were under 50 millimeters of water. The earth floors of old houses had been exposed by persons digging into the mounds in search of artifacts. The lemmings now were living in the tall grass on these floors and also on the outside slopes of the mounds and on the tundra immediately adjacent. All three of the situations just mentioned were underneath the snow. Only five per cent of the grass (*Dupontia fisheri*) on top of the mounds above the winter snow line had been eaten whereas directly below the winter snow line, 98 per cent of the grasses (*Dupontia fisheri* and *Arctophila fulva*) had been eaten. Only the basal segments of the grasses seemed to have been eaten during the winter. From 84 traps, which were set on 13 of these Eskimo mounds at Birnirk, on June 14, 1952, 56 traps took 56 lemmings; 28 traps were sprung but held no lemmings; and four other lemmings were observed on the mounds. This catch is more than 11 times that made eight months previously, on September 8, 1951, from these same mounds with the same number of traps. From one of the 13 mounds, 12 lemmings were trapped on June 14, 1952, as compared to one lemming taken on September 8, 1951. Another of the 13 mounds did not yield a single lemming on September 8, 1951, but yielded 15 lemmings on June 14, 1952.

At this time at Point Barrow, eroded shores of lakes and ponds that had been extensively used by lemmings in winter were being exposed by melting of the snow. By June 15, snow on the east shore of Birnirk Lake (see fig. 25) had receded from the winter range of the lemming and the animals were being forced to abandon the shores and some lemmings were seeking refuge on the higher summer range and were just starting to dig new holes and re-

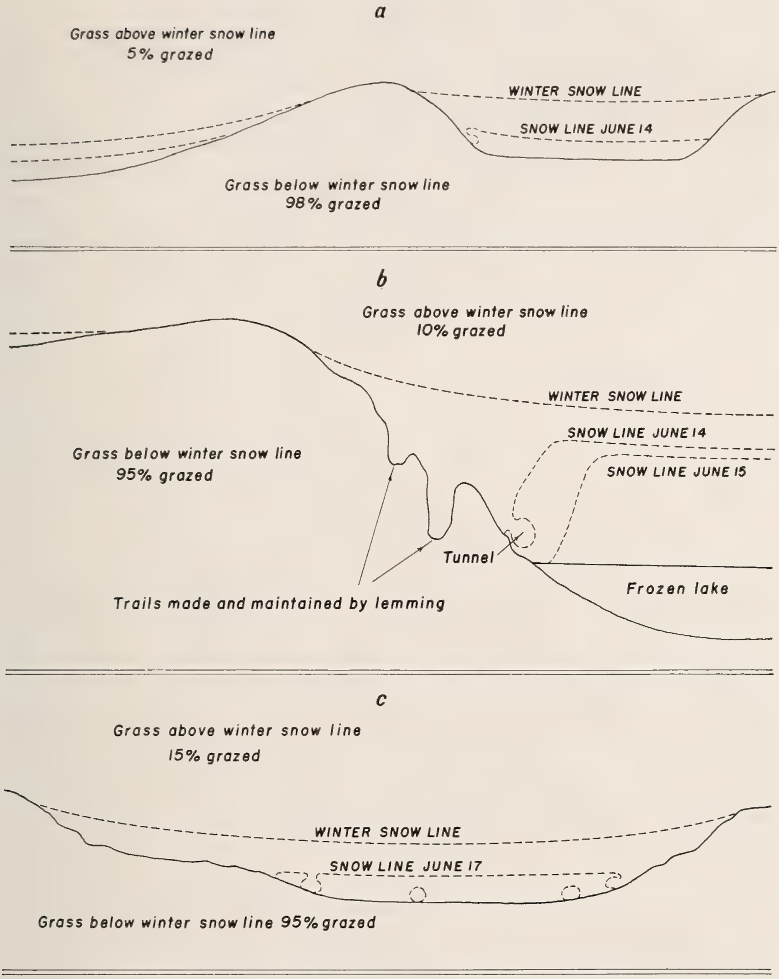

a
Grass above winter snow line
5% grazed
WINTER SNOW LINE
SNOW LINE JUNE 14
Grass below winter snow line
98% grazed
b
Grass above winter snow line
10% grazed
WINTER SNOW LINE
SNOW LINE JUNE 14
Grass below winter snow line
95% grazed
SNOW LINE JUNE 15
Tunnel
Frozen lake
Trails made and maintained by lemming
c
Grass above winter snow line
15% grazed
WINTER SNOW LINE
SNOW LINE JUNE 17
Grass below winter snow line 95% grazed

FIG. 25. Cross sections of three areas extensively used by the brown lemming during the winter of 1951-52 showing the snow line and the extent of grazing of the winter range.

a. A partially excavated Eskimo mound at Birnirk, Alaska, June 14, 1952. The lemmings were concentrated under the snow on the floor of the excavation and on the sides of the mound. × 1/70.

b. East edge of Birnirk Lake, Birnirk, Alaska, showing position of receding snow line on June 14 and 15, 1952. × 1/35.

c. Low tundra west of Fresh Water Lake, Point Barrow, Alaska, showing the snow line on June 17, 1952. On this date the tunnels in the remnants of snow were collapsing and the swales were being flooded by the melting snow thus forcing the lemmings to abandon the winter range and to re-establish themselves in the ungrazed vegetation and among the irregularities on higher ground. × 1/100.

excavate old chambers, which had been used in the previous summer. The winter trails that extended 30 meters landward from the edge of the lake were mostly abandoned. Of the winter trails, only those that were covered with snow, on land, were used on this date; these snow-covered trails that led for 10 to 30 meters onto the ice on the lake were not being used. Many of the swales adjoining the lake were uncovered and most of the lemmings from these swales now were congregated in runways at the base of the bank at the lake level. Runways at the level of the lake were 80 per cent exposed and the winter populations of lemmings were confined to the remaining 20 per cent of the land-trails covered with snow and to crevices in the bank (some as deep as 30 millimeters), which had been made and maintained by the lemmings in winter. Sixty traps placed in runways along this shore line caught 25 lemmings (39% yield), and 35 traps were sprung, whereas a sampling with an equivalent number of traps on September 8, 1951, yielded no lemmings.

The stage reached on June 17 was critical and many lemmings were abandoning winter range as a result of melting (at the rate of 4 centimeters per day) of the snow and flooding of the swales.

At this time most of the lemmings that still were on winter range were in partly exposed runways along the edge of the snow and other lemmings were in runways, in, or beneath, the snow and could be seen as dark blurred objects moving about. When a person closely approached one of these animals it invariably ran out onto the tundra instead of crossing the surface of the snow or using the runways that had been partly exposed by the collapse of the snow roofs. A few lemmings, nevertheless, were crossing the surface of snow from one raised polygon to another, especially where the snow tunnels, which connected two adjoining polygons, or areas of higher relief, had collapsed. The protective layer of snow gradually melted and by June 24 most of the lemmings had moved to summer range, to other raised areas or had fallen prey to predators.

The adjustment period in spring took place at approximately the same time throughout the area between Point Barrow proper and Barrow Village, but variations in snow cover and variations in exposure governed the exact date on which lemmings moved to summer quarters. Variation in the reproductive period is also correlated with the time of emergence of the lemmings or with their moving to new living quarters. This local movement has been mistaken for true migration by some observers. Eskimos told us that they find lemmings on inhospitable gravels along the Arctic Ocean at Barrow Village during periods of high numbers. Harmon Helmericks informed us that lemmings were seen by him on the ice and snow on the Arctic Ocean 10 miles north of Pingok Island in April and May of 1946.

In spring, when there is warm weather, green foods and more light, gonads of males enlarge and the main breeding period begins and continues throughout the summer. Changing mates and coming into contact with new individuals of the population was, in effect, increasing the reproductive potential. Such was the case in the spring when the lemmings were forced into restricted areas. Such a concentration of lemmings was favorable for breeding. There could conceively be, however, so dense a concentration that competition for food and space would inhibit breeding and prevent proper care and protection of young. In July a larger percentage of adult females was pregnant than at any other time. After July the percentage of pregnant females declined.

Nervousness in a lemming might be caused by its being driven into the home range of another lemming, by lack of overhead protection, by exposure to sunlight, by partial flooding of areas occupied, by sensing (in some way not now understood) the nervousness of the hoard of displaced lemmings roundabout, and by having to rely on a different food supply. Whatever the different food may be it probably is not superior to the regular food of winter because the new growth of vegetation will not become available until later.

Predation on the lemming by snowy owls and jaegers was most effective during, and immediately following, emergence of the lemming from under the snow; after one week of this predation the lemming population was reduced approximately 50 per cent. This great decline occurred during the period of greatest reproductive activity of the lemmings. This mortality may prevent overgrazing of the forage and thus postpone the crash. In early spring the population includes relatively few young lemmings perhaps because of their inability successfully to compete with larger lemmings for holes and for protection on higher ground. Reduction of the number of young lemmings in spring reserves food for breeding animals.

Evidence of high population of brown lemmings was obtained first in 1952, in early June, when Eskimo children at Barrow Village killed 50 or more with bows and arrows and fed the lemmings to captive polar bear cubs.

During the first two days after the general emergence of lemmings from the protective layer of snow, in the most favorable areas of the elevated and dissected polygons, there were approximately 50 lemmings per acre. Outside these optimum areas there were approximately 20 lemmings per acre. In the low flat polygons that were almost completely inundated there were neither lemmings nor their runways. One favorable area of 30 × 30 meters produced eight lemmings; another area, ¼ of an acre, produced two lemmings.

Summer of the Fourth Year (1952) of the Cycle

The population declined during early summer until late July when new plants had grown high enough to provide overhead protection. At about this time the young lemmings of the first generation of the summer had begun to forage. This population continued to increase, but there was increasing pressure from predators seeking food for their offspring. As summer advanced, the population pressure was relieved because lemmings moved for as far as 3 to 30 meters into low and previously inundated areas and foraged on higher areas after the summer vegetation there was high enough to provide the required amount of protection.

Autumn of the Fourth Year (1952) of the Cycle

By autumn, the lemming population had increased as a result of proliferation in summer, diminishing predation, and increasing overhead protection. By late autumn of 1952, 558 lemmings had been trapped by us as compared with only 56 lemmings in the summer (July, August, September) of 1952 with equal expenditure of time and effort. Lemmings, in 1952, were more generally distributed and were not confined to local and compact groups as they were in the autumn (September) of 1951.

During the transition from autumn to winter the population was slightly reduced, especially the number of young that still were in the nest. On September 8 of 1952, we found five nests with dead young. The period, when autumn gives way to winter, is nearly as hazardous for lemmings as the period of adjustment in early spring. Again, there is flooding of much of their range and because the temperatures are decreasing instead of increasing as in spring, hazards for existence are even greater. At this time almost all of the elevated areas that have optimum overhead protection are used. Many marginal areas that were not used in the previous year were used at this season. Some of these were low, moist, flat, and supported short grass. The trails that were used in these areas were 70 per cent exposed when viewed from above but were below the surface of the ground and in some instances were in raised corridors beneath mantles of mosses and lichens. The first ice that formed among the inundated grasses permitted lemmings to re-enter such previously flooded range. Snow gave complete overhead protection in higher grasses. There was less activity in unprotected trails; nevertheless, many main thoroughfares were used during snow storms. At such times snow lined the bottoms and sides of runways. Trails, which held water before the freeze came, later had floors of ice and the lemmings used them.

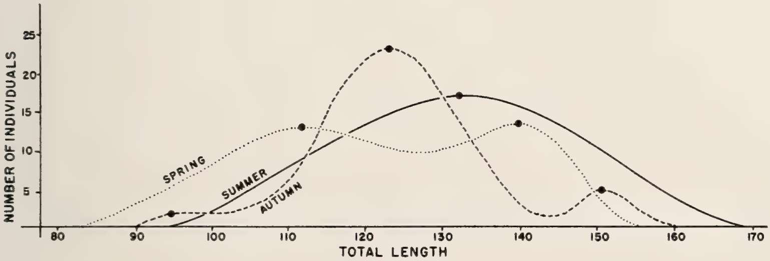


Fig. 26. Fluctuations in the population of the brown lemming on the Arctic Slope of northern Alaska in 1952. Frequency distribution of the brown lemming (both sexes combined) for spring (June 15-16, Birnirk, 110 individuals); summer (July 24-30, Lake Schrader, 84 individuals); and autumn (September 4-8, Point Barrow, 94 individuals). The population of adults which had emerged from the snow is the basis of the spring population curve; the adults of the spring population and the generation of young born in the first part of the summer are the bases of the bimodal population curve of summer; the spring population, the generation of young born in the first part of the summer, and the second generation of young born late in the summer are the bases of the curve for autumn.

By summer's end the high population and the reduced amount of available forage combined to make conditions less favorable for lemmings. Increased environmental resistance continued during the following winter, and the summer of 1953. If the vegetation is not consumed by autumn of the fifth year (1953), certainly the crash will occur during the winter of the sixth year (having in mind the condition in 1952-1953). Local populations will be extirpated and only those individuals living under optimum conditions, as concerns protection and forage, will survive to reproduce.

Probable Cause of Cyclic Fluctuations

Cyclic fluctuations in population do not occur on all parts of the Arctic Slope of Alaska at the same time, and in a given year the fluctuation may vary in magnitude from place to place. Lemmings in the Brooks Range are in marginal habitat and are in direct competition with other microtines. Lemmings farther north live in optimum habitat and have notably less competition from other microtines. Our evidence is to the effect that the magnitude of the fluctuation in size of the population of the brown lemming is less in the Brooks Range than farther north.

Cyclic fluctuation on a regional basis seems to be caused as follows: At irregular intervals, unfavorable weather equalizes all populations (by decreasing most of them), over an entire region. Lemmings then increase in an arithmetical progression and the increase is followed by a sudden decline when the food supply has been exhausted. Two, three or four such fluctuations may occur without the climate exerting any appreciable control and by the end of this time, say after ten to fifteen years, fluctuation may not be in the same stage in all parts of a given region. Eventually, a widespread climatic condition again may equalize all populations to an early stage of the "cycle." Probably it would be correct to say that between such years of decimation because of climatic extremes, climate is at most only directive in effect.

Migration and Dispersal

There seems to be no true migration of the brown lemming on the Arctic Slope of Alaska. The shifts observed by us were seasonal adjustments. As the high point in population was approached there was increasing evidence of the young lemmings being forced to peripheral and marginal areas. In the winter of 1946 Harmon Helmericks, as noted above, more than once saw lemmings on the ice of the Arctic Ocean some 10 miles from shore. The year 1946 normally would have been, and probably was, a high point in the population fluctuation. The lemmings 10 miles out to sea on the ice probably were some of those seeking a new home after having exhausted the forage on the original home site. To learn how rapidly and under what conditions lemmings could travel, several tests were made on September 8, 1952, when there was no wind and when the air temperature was 32 degrees F. A female lemming (128 millimeters in total length) was released on the snow and was forced to move. It traveled one and a half miles in an hour and 20 minutes. A male, measuring 118 millimeters in total length and unfatigued, was placed in a freshwater lake and swam for seven and one half minutes before it died from exposure. The pelage of its back was not wet. Lemmings with wet fur die in only a few minutes. A fatigued lemming (the one which had traveled 1½ miles on the surface of the snow) was placed in water for 15 seconds, until the fur was saturated, and then was placed on snow. The lemming moved four meters and died in eight minutes. A freshly caught unfatigued male measuring 117 millimeters in total length was subjected to the same experiment and lived for 21 minutes. It was concluded that large bodies of water cannot be successfully negotiated by swimming.

The brown lemming seems to have the ability to establish a direction and the ability to travel in a straight line in that direction when forced to move over the surface of the snow. A female, measuring 128 millimeters in total length, was released on the surface of the snow and allowed to move 50 meters in any direction and then was returned to the point of release. In ten trials, this lemming each time moved away in the same direction from the point of release. Once the direction for travel was established, forced deviation by us was resisted. On June 21, 1952, we examined the area between Point Barrow proper and the Birnirk area on the Point Barrow Peninsula. There were no lemmings in the area at that time but we found that in previous years, perhaps during the last high point in the population, lemmings had utilized isolated areas of grass. These areas were separated by two miles of inhospitable bare gravels from areas inhabited in 1951 and 1952. We concluded that it would require another year of population increase to force lemmings across these gravels.

Territory and Home Range

One lemming, to the exclusion of any other, used 36 square meters in a year of low numbers. Each of several other lemmings used as few as 3.4 square meters in a year of high numbers. The size of the territory seems to depend on the density of the population. During periods of high numbers, after the population is stabilized by seasonal adjustments, there is a defense of a territory. After lemmings are removed from a local area others do not immediately invade it. Each of several large lemmings used 20 linear meters of runway.

Reproduction

Size increases with age in the brown lemming. By ascertaining the numbers of individuals of each of several sizes in a given population at a given time it is possible to ascertain the numbers present of each of the several ages making up the population. Between June 15 and September 12, in the two years in 1951 and 1952, a few more than 550 individuals were measured.

Total length of the animal (see fig. 26) at Point Barrow, in the period June 15 to 19, 1952, average 133 (96-171) millimeters. A curve based on these measurements is unimodal. The absence of young animals less than 96 millimeters long is noteworthy and reflects cessation in reproduction immediately prior to the time of emergence of the animals from beneath the covering of snow.

In mid-summer (July 24-29) at Lake Schrader, a curve based on the total lengths is bimodal; one peak is at 112 millimeters and the other is at 140 millimeters.

In autumn (September 4-9) at Point Barrow, a curve based on the total lengths is trimodal and the curve is skewed to the left. The peaks are 93 millimeters on the left representing the latest crop of young, 122 millimeters representing the remaining young born in the past spring, and 155 millimeters representing the remainder.

The principal reproductive cycle is in summer. The autumn population assumes a normal curve and differs from the spring population in smaller average size.

On the surface of the ground a pair of lemmings were seen to copulate for approximately three seconds and after 30 seconds to repeat the act. In both instances the female resisted. Another male was seen to pursue a female for one and a half minutes. Most of the copulation may take place below ground. On June 17, 1952, several pairs of lemmings were unearthed from burrows. One male had three fresh cuts on the throat and others on the wrist, perhaps inflicted by a female.

When the population emerges from beneath the snow in spring the ratio of adult males to adult females is 50-50. By the end of June the ratio is 49 adult females to 51 adult males. By the end of July and the first of August (July 24-August 4) it is 45 adult females to 55 adult males. Between August 28 and September 10, there is a decided change in sex ratio; the ratio at that time is 41 adult males to 59 females. Of the 485 specimens of all age groups 242 were females and 243 were males. Unusual disproportional ratios, in combination with other factors, might be an important factor in the abrupt decline in numbers at the end of the population fluctuation. It is significant that in spring when the numbers of each sex are equal, the rate of reproduction is highest and that as the ratio varies from 50-50 the rate of reproduction declines.

Males average 1.56 per cent larger than females (see fig. 27). In cranial measurements the greatest difference between sexes is in the width of rostrum and nasals each width being approximately 3.6 per cent larger in males. The least difference is in width of the braincase (mastoid breadth and width of braincase between supratympanic fenestrae). Females are larger than males in length of maxillary tooth-row and in zygomatic breadth. The greater occipitonasal length and condylobasal length in males is caused by longer nasals and longer rostrum in males.

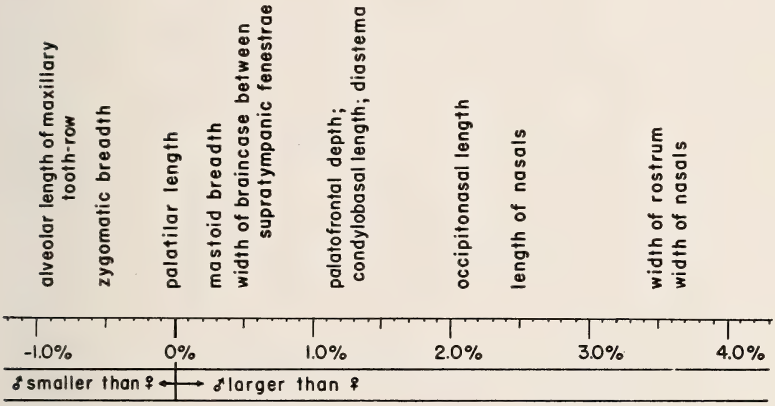


FIG. 27. Sexual dimorphism in the brown lemming. The percentage of difference between the sexes is based on 13 measurements of the skulls of 62 adult males and 62 adult females, which were trapped in the spring and autumn of 1952 at Point Barrow, Alaska. The sample of females exactly complements the sample of males in age indices (90°-99°) explained on page 112 and in figure 40.

Size of testes increased during spring and decreased in late summer (see fig. 28).

In the summer of 1952, between June 15 and September 8, there was a cycle of increase and decrease in the number of pregnant females (see fig. 29). The size range of pregnant females was 108 millimeters to 157 millimeters in total length.

The number of embryos per 100 lemmings, in 1952, was 45 in the spring (June 15-19), 210 in the summer (July 24-29), and 44 in the autumn (September 4). Number of embryos per female at these three periods averaged 8.1, 6.4, and 4.7. The average length, in millimeters, of these embryos was 6.4, 8.0, and 16.1. Reduction in average number of embryos per female with advance of summer involved all of the age groups of the breeding population (see fig. 30) and was perhaps caused by the physiological weakening of the

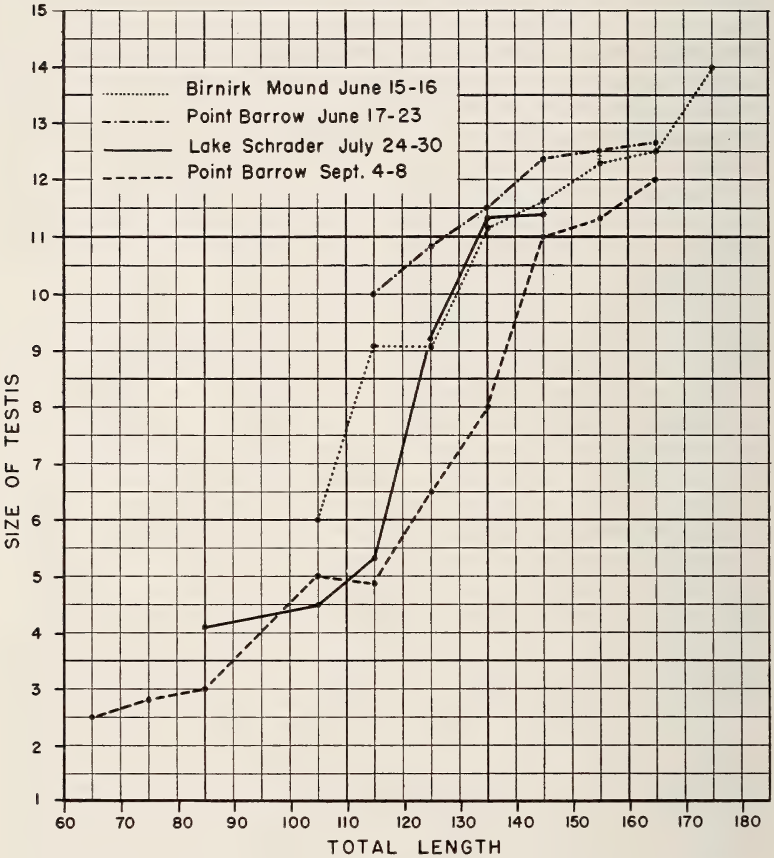


FIG. 28. Change in size of testes of breeding males of brown lemmings in the summer of 1952 at Point Barrow and Lake Schrader, Alaska. The ratio of greatest length of testes to total length of animal, shows that on June 15, at the time when the lemmings were emerging from the snow, the testes were enlarged and that they increased until at least June 23. In early September the testes were 26 per cent smaller than in spring. In this time, between June and September, the length of the testes changed more in lemmings that were 110 to 140 mm in total length than in lemmings that were shorter or longer.

reproductive process as a result of overtaxing the females with breeding (even while young were still being suckled) and other enviromental causes which were controlling the physiological breeding.

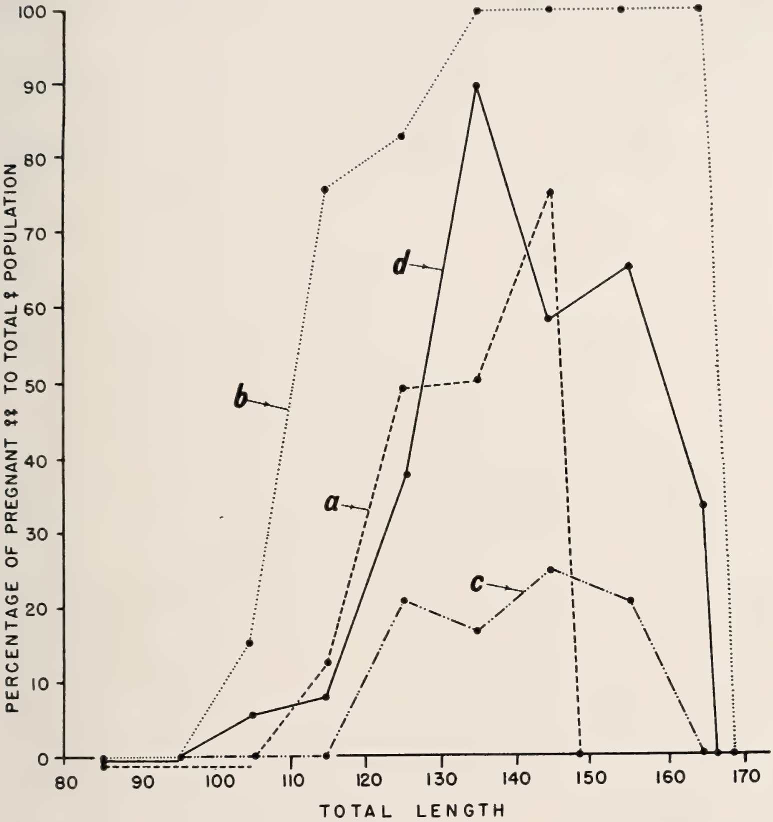


FIG. 29. Pregnant females, expressed as percentages of the total number of females trapped in three different periods of the summer of 1952 on the Arctic Slope.

a. Twenty-three pregnant females comprising 21 per cent of all females trapped in the period June 15 to 19 at Birnirk.

b. Forty-two pregnant females comprising 60 per cent of all females trapped in the period July 24 to August 3 at Lake Schrader.

c. Twelve pregnant females comprising 5 per cent af all females trapped on September 4 at Point Barrow, Alaska.

d. Average of *a, b* and *c.*

The larger numbers of embryos (from 8 to 12) tended to be in uteri that had small embryos (5 mm in crown to rump length) whereas the smaller numbers of embryos (from 3 to 5) tended to be in uteri that had large embryos (15 to 30 mm in crown to rump length). A larger percentage of embryos die and are absorbed in the uteri of old than of young females. Each of several uteri had 2 size groups of live embryos suggesting dwarf embryos. An occasional uterus had an embryo that lay partly in the vagina.

In summer, embryos in young females average longer than in females of all other age groups.

In 61 pregnant females the number of embryos average 3.6 in the right horn of the uterus and 3.2 in the left horn, but the difference was not statistically significant.

Twenty-three females, trapped at Point Barrow between June 15 and 19, had two age groups of embryos; one age group averaged four millimeters in length and constituted 82 per cent of the total number of embryos and was the result of copulation on or after June 10, and the other group averaged 31 millimeters in length and constituted 18 per cent of the total number of embryos and was the result of copulation in mid-May. Between May 19 and June 10, there was little if any breeding. This separation in age groups of

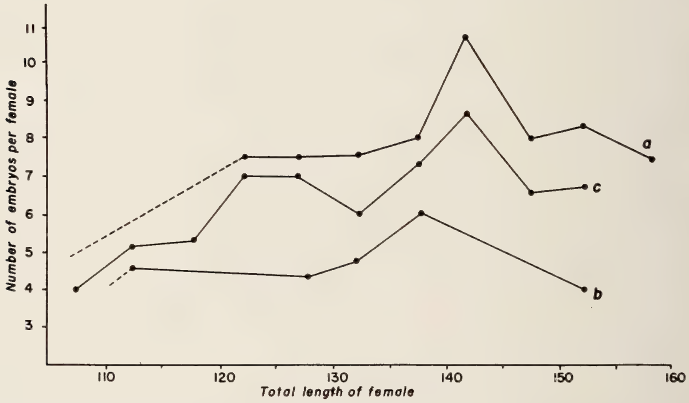


FIG. 30. Average numbers of embryos in brown lemmings that were trapped in the summer of 1952 on the Arctic Slope of Alaska. The length of the female is correlated with the number of embryos per female.

a. Average number (8.1) of embryos of 23 females trapped in June (15-16) at Point Barrow.

b. Average number (4.7) of embryos of 12 females trapped September 4-8, at Point Barrow.

c. Average numbers of embryos—based on *a* and *b* and 42 females trapped in July (24-29) at Lake Schrader.

embryos was perpetuated throughout the breeding during the summer. Forty-two females trapped at Lake Schrader between July 24 and 29 also had two age groups of embryos; one averaged eight millimeters in length and constituted 68 per cent of the embryos and the other age group averaged 24 millimeters in length and constituted 32 per cent of the population. Twelve females trapped at Point Barrow on September 4 still retained two age groups of embryos; one age group averaged 13 millimeters in length and constituted 56 per cent of the population of embryos and one group averaged 26 millimeters in length and constituted 44 per cent of the total population. The number of embryos resulting from recent pregnancies on September 4 was nearing 0.

Growth Curve

The growth curve (fig. 31) reveals a rapid increase in weight of the young in the later part of the nursing period and a decrease in the rate after weaning. A second change in rate of weight-increase occurs when young males are becoming sexually mature. The curve suggests that there is a continuous increase in size until death. The longest (171 millimeters) and heaviest (113 grams) lemming taken was a male captured on June 17, 1952, at Point Barrow.

After a gestation period of 23 days, young are born weighing 3.3 grams and measuring 45 millimeters in total length (33 millimeters in crown-rump length). The eyes open on the eleventh day when the weight is 11 grams and the length 83 millimeters. Five to six days later the young are capable of leaving the nest temporarily. A female with suckling young 14 grams in weight and 90 millimeters long was in an exposed situation outside one nest. Other groups of three to five young 26 grams in weight and 106 millimeters long were found together but not nursing. Weaning probably occurs when the lemmings, at Point Barrow, weigh approximately 17 grams and are about 95 millimeters long. As soon as rufous pelage is acquired on the rump the animals establish individual territories and live alone instead of with members of the original family group. Breeding females weigh 24 grams (108 millimeters long) to 85.5 grams (157 millimeters). In nature it is supposed that 14 months is the maximum length of life.

On September 9, 1952, in a pregnant female 151 millimeters in total length from Point Barrow, some measurements were made of the intestinal tract. Small intestine, 900 millimeters; caecum, 200 mm; connection between small and large intestine at junction of the caecum, 18 mm; large intestine, 837 mm. Of the large intestine 437 mm were in the tightly coiled absorption spiral (see fig. 32) that lay on the ventral and left side of the abdominal cavity; 400 mm of the remaining part of the large intestine contained 24 pellets

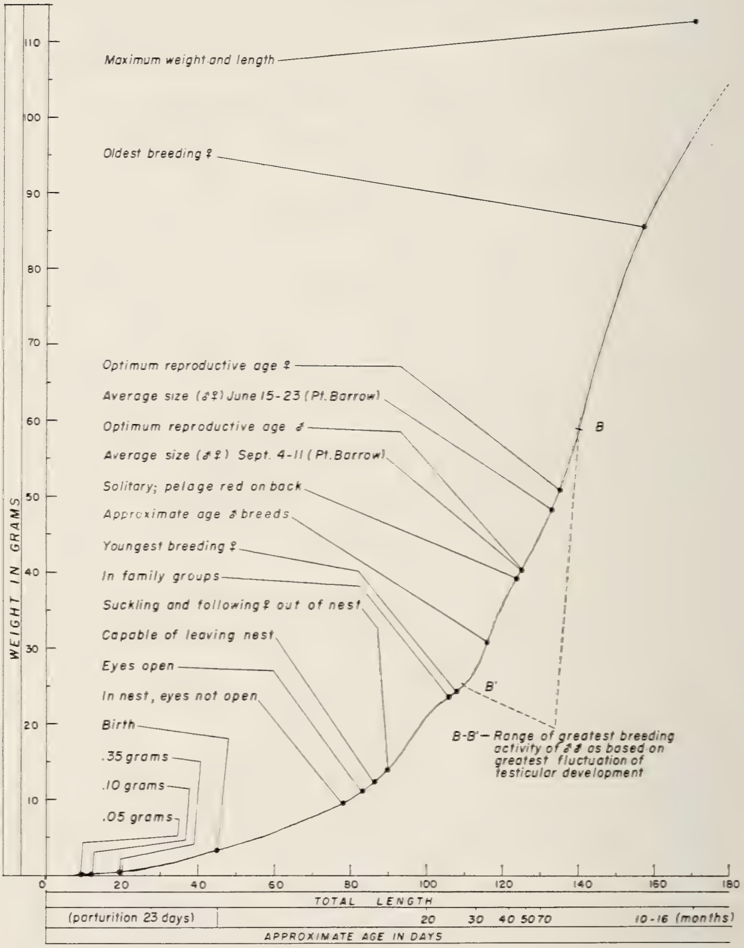


FIG. 31. Growth curve, based on 270 males captured dead from June 15 to September 9, 1952, from 27 localities representing major areas of the Arctic Slope. The curve is computed from two variates; weight and total length. Information concerning females is added and is derived from 270 females taken at the same times and places as the males.

separated by intervals of 8 to 24 mm. The pellets themselves varied from 4 to 12 mm long. Of the total weight of the animal (105 grams) the digestive tract made up 20 per cent; the pelt 12 per cent, and the five embryos (averaging 25 mm in crown-rump length) 24 per cent.

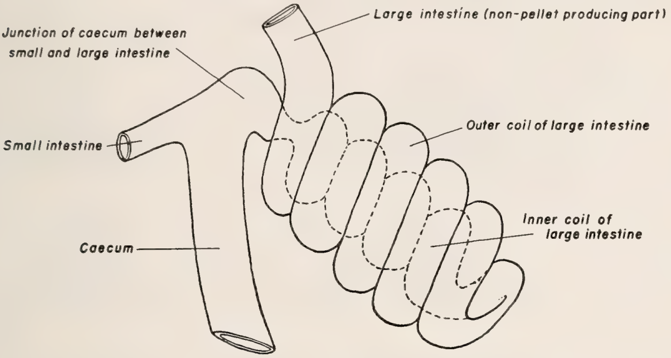

Large intestine (non-pellet producing part)
Junction of caecum between small and large intestine
Outer coil of large intestine
Small intestine
Inner coil of large intestine
Caecum

Fig. 32. Absorption coil of the digestive tract of the brown lemming. From a female measuring 135 mm in total length and trapped at Point Barrow, Alaska, on September 8, 1952. × 2.

Pelage

Hair of the lemming, except in early stages of the juvenal pelage, may be divided into three categories as follows:

Guard Hair.—Distal $5/13$ black; remainder gray; longest hair; terminal (black) part stiff; present on only back and upper parts of sides (fig. 36); resists abrasion better than other types of hair.

Cover Hair.—Differs from guard hair as follows: Distally yellow instead of black; more elliptical (less rounded) in cross-section and bends more readily at base of colored part; shorter; tends to lie flat instead of sticking straight up.

There is specialized hair on the cheeks, associated with an area of thickened skin that can be readily felt in adults. The coarse hair on the cheeks is not typical of either cover hair or guard hair. The animals bite one another on the cheeks. The longest hair on the body grows from the sebaceous glandular area on the center of the rump. In the course of fighting, the animals lose hair from this area. The flesh side of the skin on the rump always is pigmented and the hair growing there, at least in adults, is always covered with a film of oil.

Underfur.—Merely smaller cover hair; most prominent on areas of the body that are subject to least abrasion.

Melanistic individuals and albinos are known. Areas of white hair occur in some specimens on the anterior half of the mid-ventral line of the body; usually there also are two to five white hairs where areas of molt meet on the side of the lemming, but such white hairs are also found elsewhere.

Sequence of Pelages

An individual lemming that is born in July has four different pelages by early winter. These pelages are juvenal, post-juvenal, pre-adult and winter-adult. If the lemming lives into the second winter there are three more pelages, namely, spring-adult pelage, breeding-adult pelage, and winter-adult pelage. If a lemming is born in July and lives 12 months it has six different pelages owing

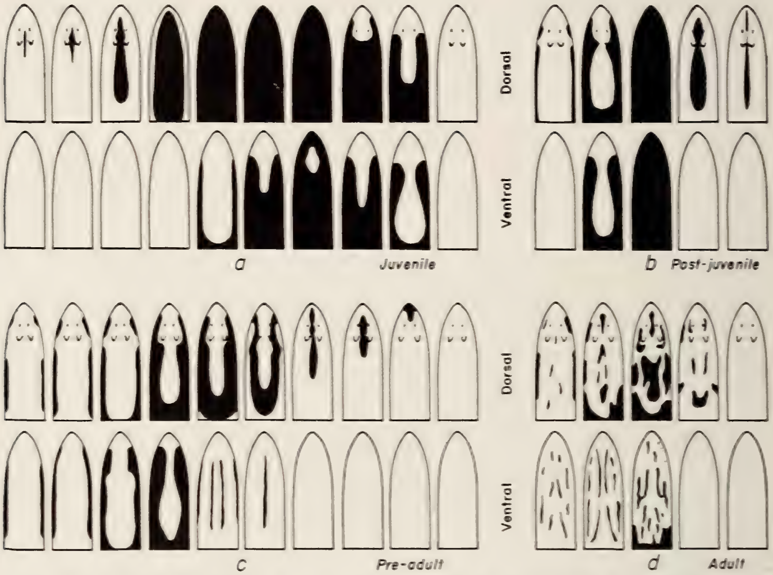


FIG. 33. Pigmentation of the skin, indicative of growth of hair, in several age-groups of *Lemmus t. alascensis*. A series of 450 specimens collected at Point Barrow, Alaska, in June, August and September of 1951 and 1952 was used to ascertain the sequence of pelages. The pigmented areas were outlined by study of the hair-side of the skin.

a. The sequence of advancing and receding pigmentation from the hairless young to fully-haired juveniles. The pigmentation progresses from the dorsal to the ventral side of the body, and disappears in the same order.

b. In post-juveniles, pigmentation and hair growth begin low on the sides and advance both dorsally and ventrally. The pigment disappears last on the midline of the back. In juvenal pelage, and also in post-juvenal pelage, new hair grows over a larger area of the body at one time than is the case in any pelage subsequent to the post-juvenal pelage.

c. In pre-adults the expanding pattern of pigmentation follows nearly the same course as in the post-juveniles but less rapidly. The dorsal part of the body always is the last part to acquire hair.

d. Spring-adult pelage begins at several centers of growth. In general, the new hair appears first on the sides and then on the back and venter (somewhat as in pre-adults) but in a few animals the new hair appears first on the back and then on the sides (somewhat as in juveniles).

to the growth of as many crops of hair and owing to at least two molts (loss of hair). These pelages are juvenal, post-juvenal, pre-adult, winter-adult, spring-adult and breeding-adult (see figs. 33, 37 and 38).

Actually, eleven pelages are distinguishable in our sample of brown lemming from Point Barrow, owing to the time of the

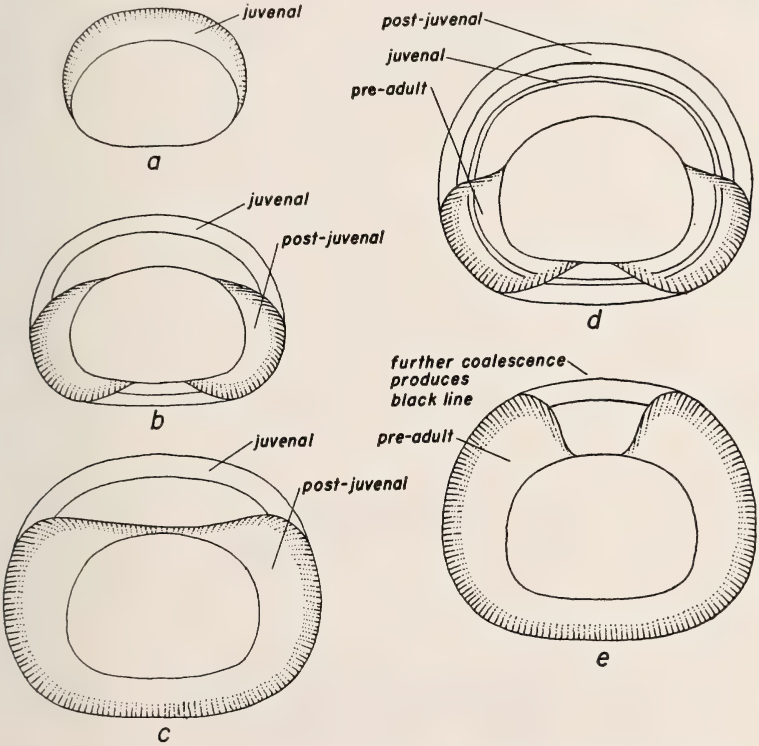

juvenal
a
post-juvenal
juvenal
pre-adult
d
juvenal
post-juvenal
b
further coalescence produces black line
pre-adult
juvenal
post-juvenal
e
c

Fig. 34. Significant stages in the growth of pelage of the brown lemming from Point Barrow, Alaska—as seen in a transverse cross-section through the center of the body. Approximately × 1.

a. Juvenal pelage showing hair growing on the back and sides; later it will appear on the belly.

b. Incoming post-juvenal pelage advancing dorsally and ventrally.

c. Later stage of incoming post-juvenal pelage. Advancing hair lines have just met on the back. The pelage of the venter is completely grown while the pelage on the back is just starting to grow.

d. Pre-adult pelage advancing dorsally and ventrally. The post-juvenal pelage has pushed through the old juvenal pelage.

e. Advanced stage of pre-adult pelage. The advancing hair line, in some specimens, consists of only three or four individual hairs of different lengths. The old post-juvenal pelage may produce a dark dorsal line bordered by the newer incoming pelage.

year when the animal is born. These pelages are: summer juvenal, winter juvenal, summer post-juvenal, winter post-juvenal, spring pre-adult, summer pre-adult, breeding pre-adult, winter pre-adult, winter-adult, spring-adult, and breeding-adult.

Juvenal Pelage. Lemmings are born without hair. Dark pigment shortly appears on top of the head, then in an expanding pattern posteriorly along the back, and laterally over the sides to the mid-ventral line. The pectoral region is the last to become pigmented. The compactly arranged yellow hair of the early stage of the juvenal pelage becomes the thinly haired gray pelage of the fully haired juvenal animal. Juveniles born in late winter have long hair in which the shorter post-juvenal and pre-adult pelages can be seen as a distinct sub-apical line when the hair is parted. The retention of the juvenal pelage during the development of the post-juvenal and pre-adult pelage greatly influences the color of the later pelages. In September the post-juvenal hair of animals on which the pre-adult pelage is just beginning to grow, is much more worn than of animals of the same age in June. The worn post-juvenal pelage of autumn is blackish.

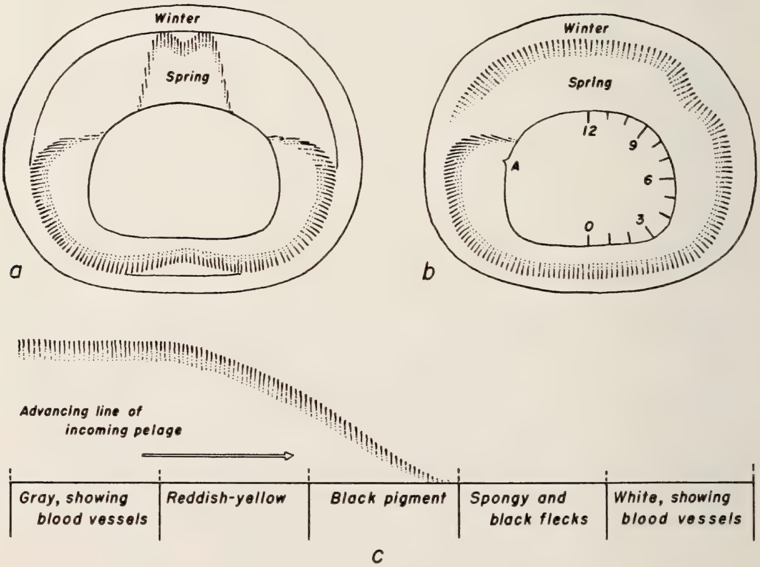

Winter
Spring
a
Winter
Spring
12
9
6
3
0
A
b
Advancing line of incoming pelage
Gray, showing blood vessels
Reddish-yellow
Black pigment
Spongy and black flecks
White, showing blood vessels
c

Fig. 35. Two stages (*a* and *b*) in the spring-adult pelage. Note that the line of growing hair that is moving dorsally has passed the lateral margin of the area that supports guard hairs (A). Approximately × 1. *c*. Changes in the skin with the advance of the line of incoming pelage.

Post-juvenal Pelage. This pelage follows the juvenal pelage and differs from all other pelages in that the hair comes in at the same time over more extensive areas and in that the growth-centers are lower on the sides of the body. From there, growth proceeds dorsally and ventrally. The areas of incoming pelage meet on the belly before they do on the back. Ordinarily all of the skin becomes pigmented before the new hair can be seen. The hair in juveniles of winter is slightly longer than in juveniles in summer.

Pre-adult Pelage. This pelage begins to grow in about the same areas where the post-juvenal pelage begins, and the areas of growth are extended in approximately the same way but the areas where hair is growing are only narrow bands—a fraction of a millimeter to as much as 12 millimeters wide. As is the case in each of the incoming pelages, the growth of the hair and the progress over the skin of the band of growth slow down when the lower margin of the area of the black guard hairs is reached by the ascending growth-line. Animals which acquire pre-adult pelage in the latter part of the winter go into a spring pelage, whereas animals which acquire their first pre-adult pelage in spring seem to go directly into breeding-adult pelage. Pre-adults change to winter pelage before adults do.

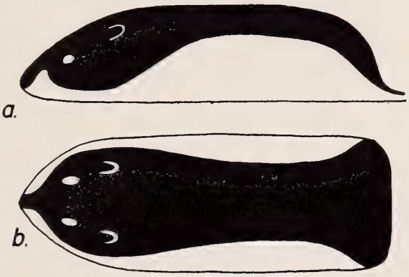


Fig. 36. Distribution of black guard hairs. These guard hairs are slightly more numerous anteriorly than posteriorly. × ½.

Winter-adult Pelage. The pelages previously described are attained by the growth of hair; the winter-adult pelage, on the contrary, is attained by means of a molt as well as by a growth of new hair. Adults that previously molted now have new hair beginning to grow from several centers at the same time. The new hair is paler than the old hair. This new hair is brighter yellow than the hair of the pelage in late winter. We lack specimens taken in winter and therefore cannot say whether the difference in color between the pelage of late autumn and early spring is the result of a change in the color of the hair or the result of a growth of new hair. The pelage of late autumn is more worn than the pelage of late winter and early spring.

On several specimens taken in September, new hair is coming in that is the same dark color as the breeding-adult pelage of summer; we have no explanation to offer.

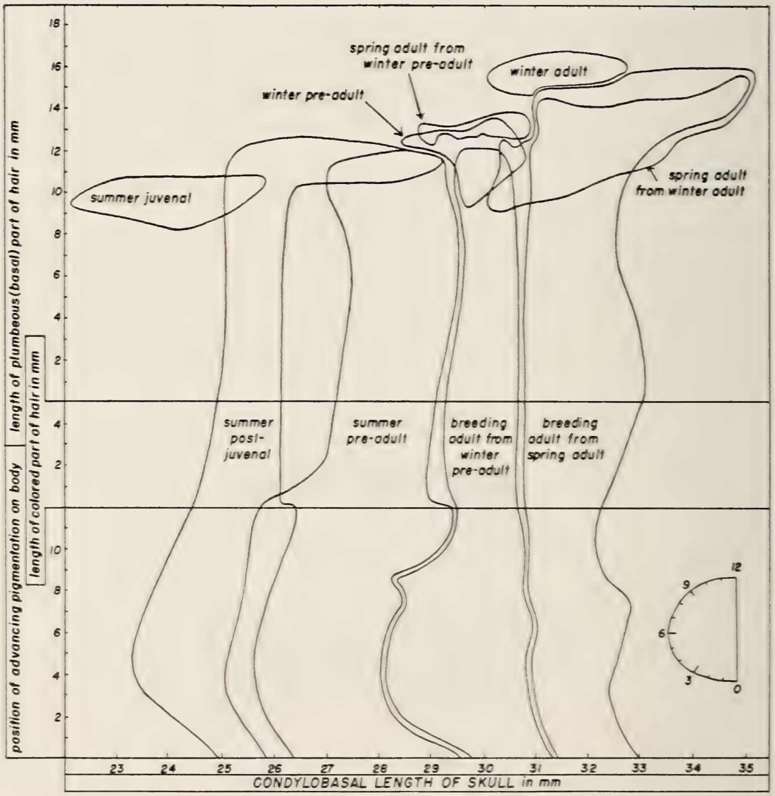


FIG. 37. Conditions of pelage in 174 males and females of the brown lemming, on June 15-23, 1952, taken at several coastal localities between Barrow Village and Point Barrow, Alaska. The perpendicular scale consists of three separate units; the lower unit shows equal divisions of one side of the animal from the ventral midline to the dorsal midline (see lower right hand insert); the middle unit shows the length of the colored (distal) part of the hair from the middle of the back (position 12 in lower right hand insert); and the upper unit shows the length of the plumbeous (basal) part of the same hair. The three units, in the aggregate, express progressive advance of hair growth and the advance and regression of the pigmentation of the skin which is the precursor of the hair growth.

In general the pelage is duller in females than in males, especially in the post-juvenal pelage and pre-adult pelage. Females are less regular in time of pelage-change in all age groups and in the main make the change later than the males.

In exceptional specimens the area of new hair expands more rapidly on one side of the animal than the other side; and in one or two specimens an area of incoming hair seemed to have extended across the mid-dorsal line.

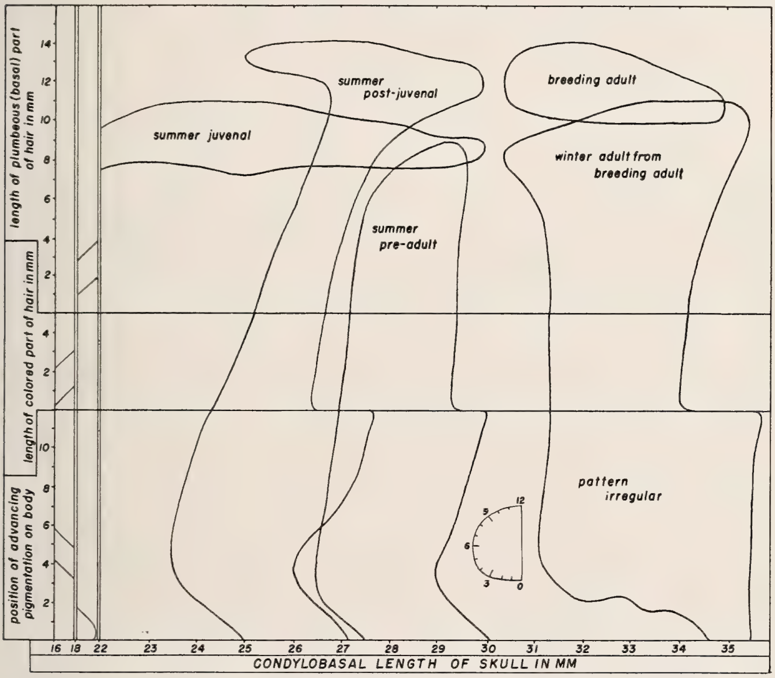


FIG. 38. Condition of pelage in 88 males and females of the brown lemming on September 4-9, 1952, taken at several coastal localities between Barrow Village and Point Barrow, Alaska (see explanation of preceding fig. 37).

The growth of new pelage in the entire population occurs in a shorter time in autumn than in spring.

SPRING-ADULT PELAGE. The long hair of the winter pelage of adults and the long hair of the pre-adult pelage which developed in slightly younger animals during late winter is lost in spring by molt. Long hairs of the old pelage remain in place while new hair is growing and cause the spring-adult pelage to be paler than would otherwise be the case. The new spring-adult pelage begins to grow at several, instead of a few, centers. These centers of hair growth generally develop at the same time and the resulting pigment in the skin causes it to be mottled. In some individuals, but rarely so, hair begins to grow on the sides above the lateral line and progresses ventrally to the mid-ventral line. In some other animals the hair begins to grow below the lateral line and above the lateral line at the same time and the expanding areas of new hair meet immediately above the line that circumscribes the guard hairs. In still other individuals, hair begins to grow only below the lateral line and these areas of new growth enlarge until they meet on both the mid-dorsal line and mid-ventral line.

BREEDING-ADULT PELAGE. The breeding pelage is perhaps the most difficult to detect of all of the pelages. It grows in an orderly manner, however, and attains the same length as the spring-adult pelage. When in place, the breeding-adult pelage intensifies the reddish color of the coat. The brightest pelage, particularly on the sides, is the fresh breeding-adult pelage. It occurs only in spring and succeeds the spring-adult pelage, or the pre-adult pelage that was acquired in winter. The breeding-adult pelage is retained throughout the summer until fall. The breeding-adult pelage is grown at the time when lemmings are becoming physiologically capable of breeding.

For map showing record stations of occurrence see fig. 41 on page 113.

Records of occurrence.—Specimens examined, 327: Nos. 43257-43262, 43266, 50540-50544, 50546-50607, 50619-50688, 50731-50749, 50758-50759, 50761-50763, 50765, 50766-50804, 50818-50829, 50834-50846, 50854-50860; skulls only, 50545, 50608-50618, 50750, 50756, 50757, 50830-50833, 50852, 50853; skeletons, 50751-50755, 50760, 50805-50817, 50847-50851; alcoholics, 50689-50730. These are distributed by localities as follows: (1) Point Barrow, 156° 27′25″, 71°23′11″, 3 ft., 6 (see also Murdock *in* Ray, 1885:102; Nelson and True *in* Nelson, 1887:277; Merriam, 1900:26; W. Stone, 1900:35; Brower, 1923:9; Miller, 1924:396; Anthony, 1928:400; Hall, 1929:423; Anderson, 1937:110; Brower, 1942:123; Davis, 1944:22; Anderson, 1947:147); (2) Birnirk Mounds, 156°36′02″, 71°20′40″, 8 ft., Point Barrow, 81; (3) Point Barrow, 156°40′40″, 71°19′30″, 8 ft., 15; (4) Point Barrow, 156°39′40″, 71°19′03″, 6 ft., 113; (5) 5¾ mi. SSW Point Barrow, 157°38′, 71°19′, 1; (6) west side Salt Water Lake, 156°42′00″, 71°18′41″, 4 ft., Point Barrow, 5; (7) 1/10 mi. W Salt Water Lagoon, 156°42′02″, 71°18′26″, 10 ft., Point Barrow, 67; (8) Point Barrow, 1½ mi. ESE Arctic Research Laboratory, 1; (9) 9/10 mi. E and 8/10 mi. N Barrow Village, 156°44′15″, 71°18′20″, 8 ft., 16; (10) 1 4/10 mi. S and 6/10 mi. E Barrow Village, 156°45′25″, 71°16′20″, 20 ft., 14; (16) Meade River, 50 5/10 mi. S and 9 mi. W Point Barrow, 156°30′53″, 70°39′30″, 40 ft., 7; (18) NE Teshekpuk Lake, 153°05′40″, 70°39′40″, 12 ft., 1.

Additional records: (11) 30 mi. N Thetis Island, 150°18′00″, 71°04′40″ (seen by Harmon Helmericks, April, 1946—*fide* J. W. Bee, MS, 16 August 1952); (12) Pitt Point (seen by Clifford Fiscus, summer of 1952—*fide* J. W. Bee, MS, 8 September 1952); (13) Jonas Eskimo Camp, south end of Smith

Bay, 154°00′, 70°18′ (seen by Norman Oie, winter of 1946, 1947, 1948, 1949—*fide* J. W. Bee, MS, 26 July 1951); (14) [definite localities unspecified] Northwestern North America (True, 1884:596); throughout mainland of northern North America (Turner, 1886:204); Alaska (Trouessart, 1898-99: 546; 1904-05:463; Dufresne, 1946:141); (15) 43 mi. S Point Barrow, Meade River (seen by Ira L. Wiggins, 1951—*fide* J. W. Bee, MS, 11 July 1951); (17) Wainwright (Bailey and Hendee, 1926:20); (19) Topagaruk, 155°48′, 70°34′, 10 ft. (J. W. Bee, MS, 8 July 1951); (20) east of Teshekpuk Lake, 152°45′, 70°36′ (seen by Norman Oie, winters of 1946, 1947, 1948, 1949—*fide* J. W. Bee, MS, 26 July 1951); (21) Colville delta, Anderson *in* Stefansson (1913b: 512).

Lemmus trimucronatus subarcticus new subspecies

Type.—Male, adult, skull with skin, No. 50876, Univ. Kansas Mus. Nat. Hist., from Lake Schrader, 145°09′50″, 69°24′28″, 2900 ft., Brooks Range, Alaska; trapped on July 24, 1952, by James W. Bee; original number 520724-9.

Geographic distribution.—Brooks Range, Plateau Province and Coastal Plain east of the Colville River.

Diagnosis.—Small; temporal ridge on dorsal surface of braincase prominent; posteromedial surface of squamosal depressed, forming a deep fossa, bordered by sharp edge at contact with interparietal and well-developed lambdoidal crests; interorbital crest elevated and sharp; frontal protuberances prominent, with shallow valley between; occiput inclined anterodorsally. Pelage in breeding adult (holotype): shoulders and anterior back (17′*l*) Dresden Brown lined with black (producing grizzled effect, darkest on top of nose) whereas rump and hinder part of back (9 *n*) Chestnut; sides near (15 *j*) Mars Yellow, deepest on flanks and on lower part of face from nose to below ears (but sides of nose paler); underparts near (15′*k*) Ochraceous-Tawny; tail dusky above and below with admixture of black hairs above; antiplantar surface of hind feet near (11″*n*) Vandyke Brown; antipalmar surface of front feet sooty with light tawny. Juvenal pelage short and somber-colored becoming gray and black with wear.

Comparisons.—From topotypes of *L. t. alascensis, L. t. subarcticus* (from Lake Schrader) differs as follows: Approximately six per cent smaller in linear measurements of skull and body; posteromedial surface of squamosal depressed forming deep, rather than shallow, fossa; interorbital crest, viewed from side, convex rather than concave or straight; lambdoidal crest higher; occiput nearly vertical rather than inclined anterodorsally; frontal protuberances more prominent; maxillary tooth-row shorter; braincase seven per cent narrower as measured between supratympanic fenestrae; dorsal pelage, anteriorly, darker and more mottled.

From topotypes of *L. t. yukonensis, L. t. subarcticus* differs as follows: Approximately four per cent smaller in linear measurements of skull and body; braincase five per cent narrower as measured between supratympanic fenestrae; otherwise differing as described in comparison with *L. t. alascensis.*

From *L. t. trimucronatus, L. t. subarcticus* differs as follows: Smaller in all measurements; posteromedial surface of squamosal depressed, forming deep, rather than shallow, fossa; interorbital crest, viewed from side, convex rather than concave or straight; lambdodial crests higher; frontal protuberances more prominent; pelage duller and less gray anteriorly.

Remarks.—One of the most prominent differences between the two subspecies on the Arctic Slope is the degree of sculpturing of the posterior part of the skull where the temporal muscles attach. In *subarcticus* the ridges of the interparietal, parietal and squamosal, that border the squamosal fossae, are high and angular. Every one of the 48 males and females from the type locality of *subarcticus* has deep squamosal fossae and sharp ridges whereas most of the 160 adults from Point Barrow have relatively shallow fossae and rounded ridges. Eight per cent of the specimens from Point Barrow were indistinguishable in this respect from specimens from Lake Schrader. The degree of sculpturing of the squamosal and the development of the frontal protuberances (from least to greatest) is as follows: *trimucronatus, yukonensis, alascensis* and *subarcticus.* The lesser width of the braincase in *subarcticus* is constant because the distance between the supratympanic fenestrae remains constant after an early stage in the development of the animal. Any

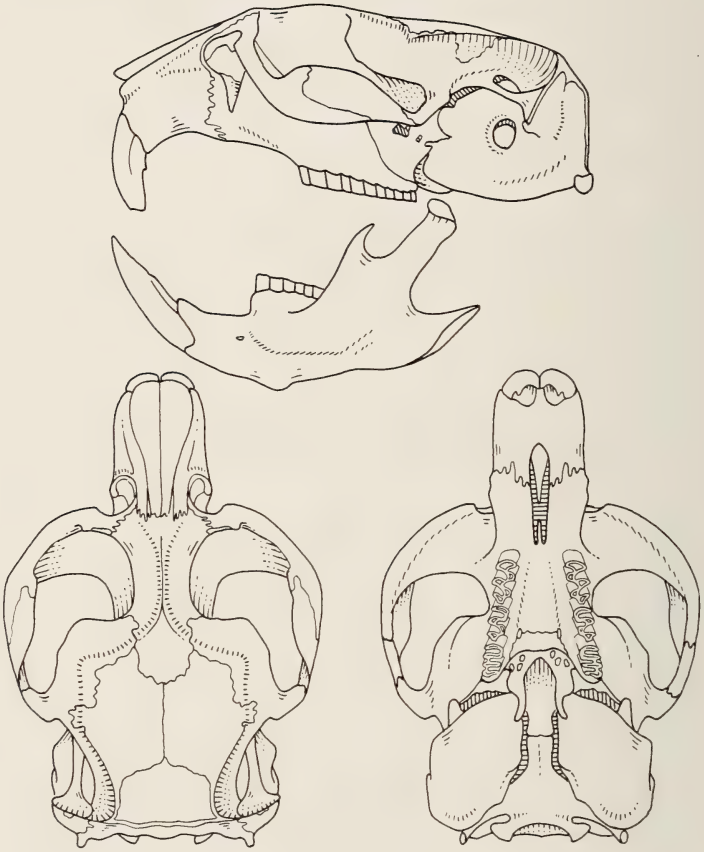
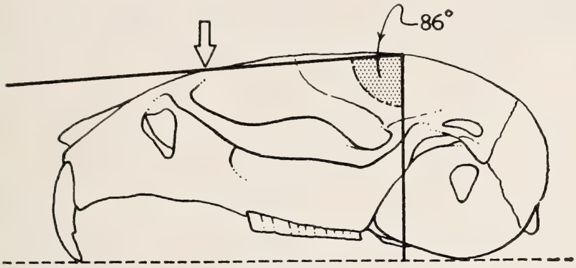
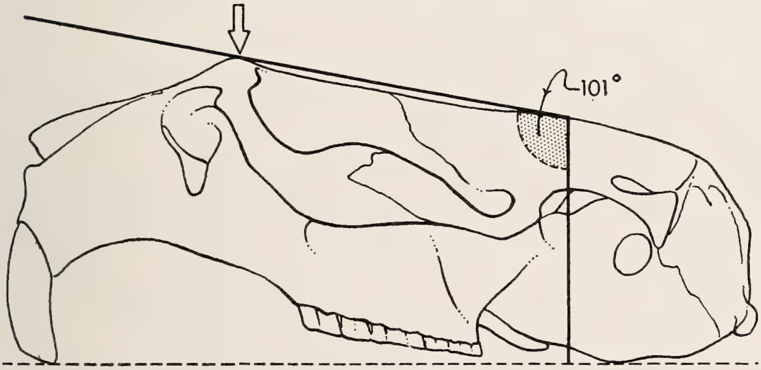


Fig. 39. Skull of *Lemmus trimucronatus subarcticus,* Lake Schrader, 145°09′50″, 69°24′28″, 2900 ft., Brooks Range, July 24, 1952, No. 50873 KU, ♂. × 2.

difference in this measurement in different populations of this species, therefore, is an expression of geographic variation. In each sex this measurement averages 9.7 mm in *subarcticus* from Lake Schrader and 10.4 mm in *alascensis* from Point Barrow. Specimens from between the Brooks Range and the Coastal areas west of the Colville River are intermediate in this measurement; the sharpest change in the cline occurs less than fifty miles inland from the coast. Condylobasal length and other linear measurements of the skull vary clinally in a similar fashion. The degree of difference between *subarcticus* and *alascensis* is greatest in the oldest individuals. Past changes, including the union of former islands with the mainland, and the mixing of partly differentiated populations may account for the greater coefficient of variation in populations along the coast.



JUVENILE



OLD ADULT

Fig. 40. Diagrams showing how the age index, referred to immediately above in the text, is obtained. The two skulls of *Lemmus* are approximately × 3.

The age index referred to in the measurements below is an angle. It can be obtained by the following described procedure. Place the skull (minus lower jaw) on a horizontal surface in such a position that the skull rests on the tips of the incisors and ventral surfaces of the tympanic bullae. Project a vertical line through the highest elevated central part of the parietal bone. Project a second line anteriorly from this point to the top of a frontal tubercle. Ascertain the inferior angle between this second line and the vertical line. The angle is more than 90 degrees in adults and less than 90 degrees in younger individuals.

Measurements.—Average and extreme measurements of 22 adult males and 26 adult females from Lake Schrader are as follows (each specimen had molted at least once and had an age index of 90° or more): Total length, ♂139(126-149), ♀139(118-164); tail, 19.5(18-22), 19.5(17-23); hind foot, 18(18-20), 18.9(17-20); ear from notch, 10.3(9-11), 10(8-12); condylobasal length, 30.3(26.8-31.9), 29.3(26.2-32.4); occipitonasal length, 30.3(28.7-32.4), 29.2(26.6-32.3); length of nasals, 9.3(8.6-10.2), 8.9(7.4-10.0); zygomatic breadth, 20.1(18.6-21.3), 19.7(17.0-21.6); interorbital breadth, 3.8(3.5-4.2), 3.7(2.8-4.1); alveolar length of maxillary tooth-row, 8.1(7.7-8.8), 8.2(7.5-9.1); width of rostrum, 5.2(4.7-5.9), 4.9(4.4-5.4); palatilar length, 16.0(14.6-17.0), 15.6(14.0-17.0); mastoid breadth, 15.2(14.6-16.4), 14.5(13.3-15.0); palatofrontal depth, 8.5(7.9-9.5), 8.0(6.9-9.3); diastema, 9.7(9.0-10.6), 9.4(8.0-10.5); alveolar length of maxillary tooth-row expressed as a percentage of length of diastema, 84(79-90), 88(83-100); width of nasals, 3.9(3.6-4.3), 3.8(3.2-4.4); width of braincase between supratympanic fenestrae, 9.7(8.9-10.5), 9.7(9.1-10.5); width of braincase expressed as a percentage of condylobasal length, 31.0(29.0-35.8), 30.2(26.4-34.4); age index (see above in *Remarks*), 96.9°(90°-100°), 95.3°(90°-99°).

Records of occurrence.—Specimens examined, 173; Nos. 43263-43265, 43267-43276, 43278-43320, 50861-50965 (50883, 50890, 50931, 50943 and 50944 are skulls without skins); M. C. Z., 11898, 11899, 11901, 11902, 11906-11908, 11911, 11914, 15940; U. W. Z., 13993, 13994. These are distributed by localities as follows: (2) Kaolak River, 159°47′40″, 70°11′15″, 30 ft., 10; (3) Barter Island, 1 (U.W.Z.) (see also Barkalow, 1952:199; Strecker and Morrison, 1952:180; Rausch, 1953:126); (5) mainland ¼ mi. from Barter Island, 1 (U.W.Z.); (8) Humphrey Point, 5 (M.C.Z.); (9) Kaolak, 160°14′51″, 69°56′00″, 178 ft., 28; (10) Demarcation Point, 5 (M.C.Z.); (11) Gavia Lake, N White Hills, 150°00′, 69°35′, 460 ft., 2; (12) Lake Schrader, 145°09′50″, 69°24′28″, 2900 ft., 71 (see also Rausch, 1951:181); (13) E side Lake Schrader-Lake Peters channel, 145°09′30″, 69°24′15″, 2905 ft., Brooks Range, 3; (14) Bearpaw Creek, 1$\frac{7}{10}$ mi. E and 1$\frac{7}{10}$ mi. N Umiat, 152°04′50″, 69°23′30″, 550 ft., 1; (15) 1$\frac{3}{10}$ mi. E and 1$\frac{3}{10}$ mi. N Umiat, 152°05′30″, 69°23′12″, 350 ft., 2; (16) $\frac{9}{10}$ mi. W and $\frac{9}{10}$ mi. N Umiat, 152°10′58″, 69°22′53″, 380 ft., 1; (17) 1½ mi. W and ¾ mi. N Umiat, 152°08′10″, 69°22′18″, 370 ft., 3; (18) Umiat, 152°09′30″, 69°22′08″, 352 ft., 1 (see also Rausch, 1950b:136; 1950c:466); (19) Mount Mary, S end Lake Peters, 145°10′02″, 69°20′30″, 2920 ft., 6; (20) Wahoo Lake, 146°58′, 69°08′, 2350 ft., Brooks Range, 1; (21) 2 mi. W Utukok River, 161°15′30″, 68°54′50″, 1275 ft., 4; (22) Driftwood, Utukok River, 161°12′10″, 68°53′47″, 1200 ft., 13; (24) Chandler Lake, 152°45′, 68°12′, 2900 ft., 15.

Additional records: (1) 10 mi. N Pingok Island, 149°48′00″, 70°49′30″ (seen by Harmon Helmericks in April and May, 1946—*fide* J. W. Bee, MS, 16 August 1952); (4) Griffin Point (Davis, 1944:22); (6) Camden Bay, (Davis, 1944:22); (7) Collinson Point (Davis, 1944:22); (23) Tolugak [Tulugak] Lake (lat. 68°24′ N, long. 151°26′ W) near the head of the Anaktuvuk River Valley (Rausch, 1950b:136; 1950c:466; 1951:180).

Comparative Material.—Total, 44 specimens.

L. t. yukonensis, 17 from U. S. Nat. Mus., Biol. Surv. Coll.: Nos. 157295, 157296, 159058, 159060, 159079, 159081, 159083, 159086, 159089, 159091, 159101 from head of Toklat River, McKinley Range, Alaska; 157460, 159103 from Glacier Creek, McKinley Range, Alaska; 98847, 98848, 98850, 98851 from Charlie Creek, Alaska (topotypes).

L. t. trimucronatus (Nat. Mus. Canada unless otherwise noted), 22.—Mackenzie: Cape Bathurst, Baillie Island, 7 (12462-12468, skins only); Tuktuyaktok, 1 (12443 skin only); Bernard Harbor, Dolphin and Union Strait, 1 (2965); Port Epworth Island (Kogluktualuk), 1 (12443 skin only); Aylmer Lake, 6 (29151-29155, 29158, Amer. Mus. Nat. Hist.). Keewatin: mouth Dubawnt River, Thelon River (Tibielik Island), 4 (15365-15368); Yathkyed Lake, 1 (11135); Kazan River, 1 (11136).

L. t. helvolus, 5.—Yukon (Nat. Mus. Canada): Tantalus, 1 (1417); Nisutlin Mts., near Teslin Lake, 1 (2044); Eagle Bay, near [*sic*] Teslin Lake, 1 (2149); NE of Teslin Lake, 1 (2179); near Teslin Lake, 1 (2184).

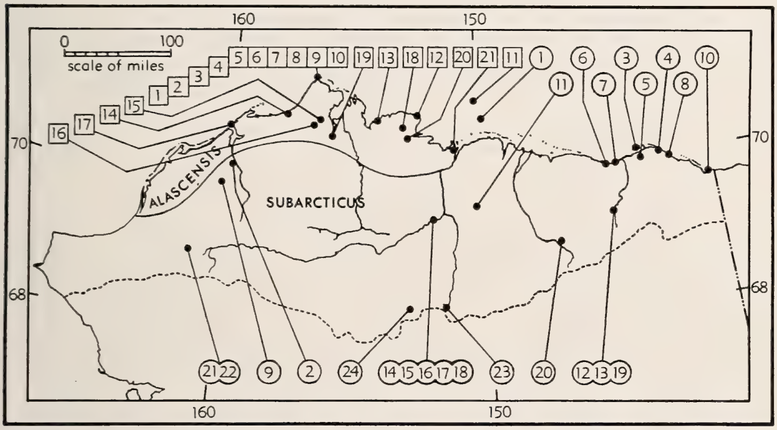


Fig. 41. Record stations of occurrence of two subspecies of *Lemmus trimucronatus.*

Clethrionomys rutilus dawsoni (Merriam)

Red-backed Vole (Avingak pamiukturuak)

Evotomys dawsoni Merriam, Amer. Nat., 22:650, July, 1888, type from Finlayson River, 3000 ft., a northern source of the Liard River, lat. 61°30′ N, long. 129°30′ W, Yukon.

Evotomys rutilus, True, Proc. U.S. Nat. Mus., 7 (App., Cir. 29):596, November 29, 1884. (Also Bailey, 1897:118; Elliot, 1901:170; Elliot, 1905: 229.)

Clethrionomys rutilus dawsoni, Rausch, Jour. Washington Acad. Sci., 40: 134, April 21, 1950. (Also Rausch, 1950c:466; 1951:182; 1953:128; Hall and Cockrum, 1953:383.)

Clethrionomys dawsoni, Burt and Grossenheider, A field guide to the mammals, Houghton Mifflin Co. Boston, p. 122, 1952.

Clethrionomys dawsoni dawsoni, Orr, Jour. Mamm., 26:70, February 27, 1945.

Description.—See colored frontispiece. Average and extreme measurements of 8 males and 15 females, all breeding, trapped from August 11 to August 24, 1951, at Chandler Lake, are, respectively, as follows: The total length, ♂ 142(137-153), ♀ 149(142-161); length of tail, 41(33-48), 40(33-46);

length of hind foot, 20(19.5-21), 20(19.5-21); height of ear from notch, 15.6 (15-17), 15(14-16); condylobasal length, 25.2(24.4-25.9), 25.4(24.5-26.7); zygomatic breadth, 13.8(13.7-14.1), 13.7(13.4-14.0); interorbital breadth, 4.1(3.9-4.3), 4.0(3.9-4.2); mastoid breadth, 10.9(10.5-11.2), 10.8(10.5-11.0); length of nasals, 8.0(7.6-8.2), 8.2(7.8-8.6); alveolar length of upper molar tooth-row, 5.6(5.3-6.0), 5.5(5.2-5.8); width of braincase between supratympanic fenestrae, 10.1(9.9-10.6), 10.1(9.9-10.4); diastema, 7.6(7.0-7.8), 7.7 (7.3-8.2); height of anterior part of braincase (palatine-frontal depth), 5.7 (5.5-6.0), 5.7(5.4-6.0); length of bullae, 5.7(5.5-6.0), 5.7(5.4-6.0); weight, 31(26-36), 34(23-40). In juvenal pelage (♀, 43433) upper parts reddish, gray of underfur producing somber shade; sides yellowish with admixture of gray; underparts dark gray with faint wash of tawny; tail bicolored, above like back, below tawny. In post-juvenal pelage (♀, 43431) upper parts near (9 *l*) Burnt Sienna; sides near (17″ *j*) Tawny-Olive; underparts gray with light wash of tawny; tail bicolored, above like back but with more yellow hairs, below Pale Ochraceous-Buff. Pre-adult pelage like post-juvenal pelage but with upper

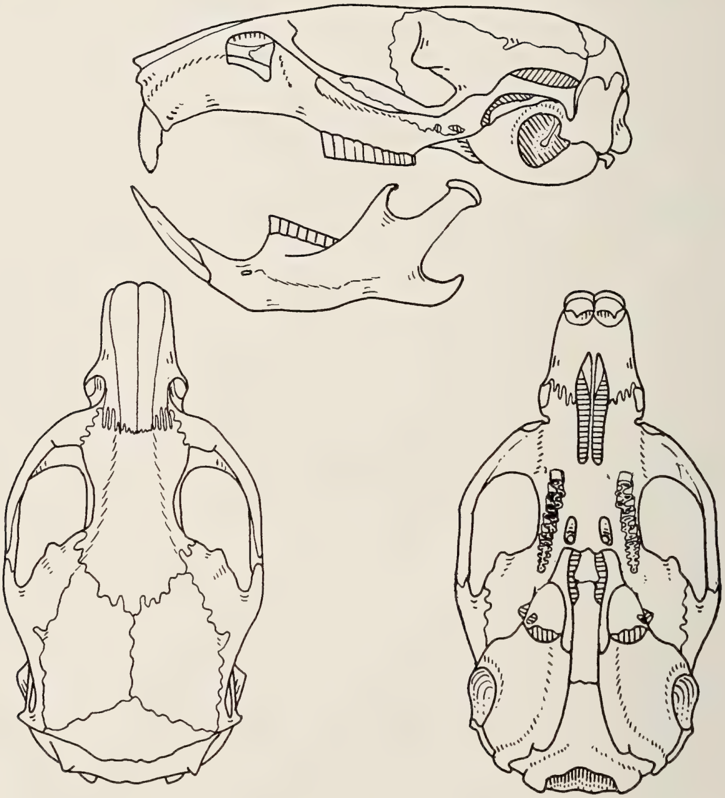


FIG. 42. Skull of *Clethrionomys rutilus dawsoni,* Chandler Lake, 152°45′, 68°12′, 2900 ft., August 23, 1951, No. 43499 KU ♀. × 2½.

parts lighter red, sides yellower and underparts with more suffusion of tawny than in post-juvenal pelage. In breeding adult pelage (♀, 50969, June 27) upper parts Auburn; sides near (17″ *j*) Tawny-Olive; underparts washed with tawny; tail bicolored, above like upper parts but with more yellow hairs, below Ochraceous-Buff. In post-breeding pelage (♀, 43492, August 20) upper parts (11 *l*) Sanford's Brown, sides Light Buff with admixture of black underparts grayish with light wash of tawny; tail bicolored, above dark brown, below like sides. Autumnal pelage like post-breeding pelage with upper parts near (11 *l*) Sanford's Brown but with more yellowish-red hairs; sides with brighter yellow; underparts more tawny. In winter pelage (♀, 42841) upper parts near (13 *l*) Amber Brown; sides (17′*h*) Yellow Ocher; underparts Light Buff; tail bicolored, above resembling back but darker, below Pale Ochraceous-Buff. Ears large and projecting above fur; tail approximately twice as long as hind foot, bicolored; mammae in 4 pairs, two inguinal and two pectoral; pelage of upper parts bright, dorsal stripe well defined, varying from reddish yellow to dark rufous, sides grayish-yellow, underparts grayish with suffusion of buff; tail bicolored varying from reddish to dark brown above, shape variable (from slender to thick, long to short, and thinly to densely haired), tail always densely haired in winter; postpalatal bridge of skull poorly formed, molars rooted, outer and inner re-entrant angles of approximately equal depth; enamel of molars less regular than in most other microtines.

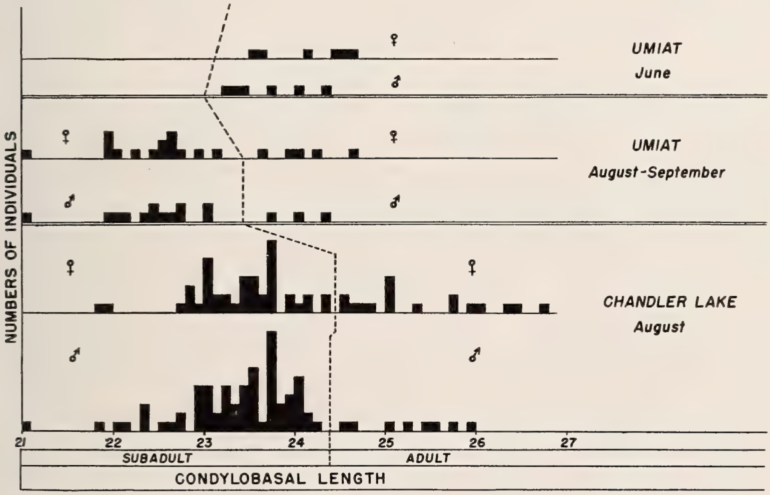


FIG. 43. Graph showing breeding adults and subadults of *Clethrionomys r. dawsoni,* from Chandler Lake situated at 2900 ft., and from Umiat at 370 ft. Those trapped from August 31 to September 4 at Umiat are smaller than those trapped from August 10 to 25 at Chandler Lake. The difference in size of animals probably reflects differences in age rather than geographic variation.

Remarks.—Individuals born in winter, and those that undergo most of their growth in winter, are smaller than those born in spring. The rate of growth of the palate, which is the last bone to ossify in the skull, is proportional to the amount of growing time under optimum conditions; on the Arctic Slope this time is a brief period in summer. Only thirty-four per cent of the skulls of breeding animals trapped in spring from June 27 to July 1 have the postpalatal bridges completely developed. In the remaining 66 per cent of the breeding animals the posterolateral angles of the medial part of the palate are not connected with the lateral parts of the palate. The pterygoid bones in these adults are pitted and the four vacuities associated with the palate are large. By autumn (latter part of August and early September) 72 per cent of the adults have postpalatal bridges completely formed.

In subadults, born in spring and therefore having grown under favorable conditions of light, temperature and green foods, 4 per cent of the postpalatal bridges are complete in August and September. The palate and pterygoid bones in all of these subadults are composed of bone that is firm and has a smooth surface; there are only a few pits in the bones and the four principal vacuities are small. The percentage of complete palates of subadults trapped in autumn is 30 per cent less than in adults trapped at the same time, but eight per cent more than in breeding adults trapped in spring.

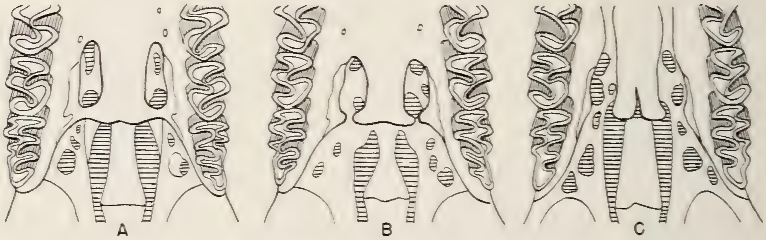


FIG. 44. *Clethrionomys rutilus dawsoni* to show individual variation in the shape and ossification of the posterior part of the bony palate. × approx. 5½.

A. Female, No. 43405 KU, Chandler Lake, 152°45′, 68°12′, condylobasal length of skull 25.4 mm.

B. Male No. 43452 KU, same locality as *A*, condylobasal length of skull 25.4 mm.

C. Male, No. 50999 KU, Mt. Mary, S end Lake Peters, 145°10′02″, 69°20′30″, condylobasal length of skull 25.2 mm.

The palates of adults of the species *gapperi* to the south, with a few exceptions, are well developed and the postpalatal bridges are complete. In the range of *gapperi* the available season for the optimum development of the palate is from six to eight months or more which is sufficient time for the development of a well formed palate, whereas in individuals of the species *rutilus* from the Arctic Slope the normal growing season is limited to 2½ months or less. On the Pacific Coast south of Alaska the period favorable for development is long. The species *occidentalis,* which lives in that region, has the posterior margin of the palate complete and provided with a median projection.

The length of the tail and the amount of hair growing from the tail is variable in *Clethrionomys.* The average length of the tail of animals living on the Arctic Slope is less than in those living in the temperate region, in accordance with Allen's Rule. The hair on the tail of animals from the Arctic Slope usually is long and dense; hair of this nature seems to be an adaptation of animals living in colder climates. There are, however, many specimens from the Arctic which have long tails and in summer the tails of some have only a sparse growth of short hair. Animals from the Arctic in winter pelage invariably have a thick bushy tail. It is on the basis of the clinal arrangement of the structure of the palate, length and covering of the tail and the color of pelage, from somber in the south to bright in the north, that one of us (Bee) suggests that *rutilus* and *gapperi* are conspecific. In the present account, however, the two are treated as separate species. In *Clethrionomys* of the Old World there may be a cline from north to south in the species that Hinton recognized.

In comparing animals from the Arctic Slope with those from south of the Brooks Range at Bettles and northeast of Fairbanks, we find the skulls of the first to be slightly larger and the pelage, on the average, lighter red with more yellow. The northern animals are more sharply bicolored and the red dorsal stripe is narrower. The adult with the greatest amount of yellow in its pelage in our series is from one and one half miles east-southeast of Point Barrow.

The red-backed vole is found throughout the Arctic Slope but is especially common in the Brooks Range and along the sides of major river valleys of the Plateau Province. At Point Barrow only one specimen was taken. In the Brooks Range in 1951 and 1952 this vole was unusually abundant.

In canyons of the Brooks Range, the red-backed vole lives higher on the slopes above the floor of the canyon than does any other microtine but on the Plateau Province, this vole lives on the sides of the valleys below areas occupied by the singing vole and above the flat floor of the valley, inhabited by the tundra vole. The red-backed vole lives also on rough parts of the valley floor where there is overhead protection. At Lake Peters the vole inhabited all of the slopes surrounding the lake but not the stabilized alluvium between Lake Schrader and Lake Peters. In the absence of trees and prostrate conifers, which in the more southern regions provide adequate overhead protection for *C. gapperi*, *C. rutilus* of the Arctic finds the equivalent in overhead protection among the rocks of slides and rock fields, especially where the spaces between rocks have been partly sealed in with vegetation. The contact between the rockslides and the open terrain beyond is most preferred. For example, the largest number of red-backed

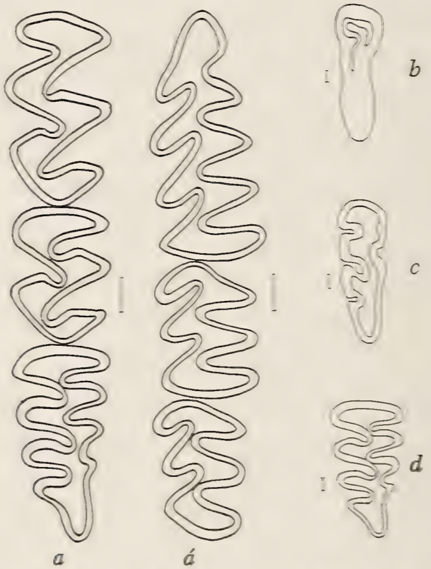


FIG. 45. Enamel pattern in *Clethrionomys r. dawsoni* to show variation.

a and *a′*. Enamel pattern of occlusal surfaces of left upper (*a*) and left lower (*a′*) cheek-teeth. Male, No. 43355 KU, 1½ mi. W and ¾ mi. N Umiat, 152°08′10″, 69°22′18″. This specimen has exceptionally angular enamel loops; compare with more nearly normal condition shown in fig. 16, *c* and *c′*.

b, *c*, *d*. Enamel patterns in last (third) upper molar of left side to show variation with wear. *d* is least worn and *b* is most worn.

b. Female, No. 43359 KU, 1½ mi. W and ¾ mi. N Umiat, 152°08′10″, 69°22′18″.

c. Male, No. 43333 KU, same locality as *b*.

d. Male, No. 43355 KU, same locality as *b*.

Actual lengths shown by line adjacent to each pattern.

voles trapped by us at any one place came from a contact between the valley and a moraine approximately 200 meters south of our camp at the south end of Lake Peters. The bases of cliffs and ledges are also extensively used. The vole is sometimes trapped in low flat areas but almost always where adequate overhead protection is afforded by shrublike plants.

Precipitation and fluctuating water levels, which are of major importance to other microtines, are of minor concern to the red-backed vole. Microtines, except the red-backed vole, which are trapped when it is raining generally have the fur wet, whereas the fur of the red-backed vole is seldom wet because of its habit of using protection afforded by the rocks.

At Chandler Lake on August 13, 1951, traps placed along the edge of a creek which was flowing among the rocks of a boulder field, caught red-backed voles. These same traps after a rain, which increased the flow of the creek, were inundated by one meter of water. Where the water was channeled among the rocks, the red-backed vole escaped it. On August 16, a red-backed vole was trapped as it left a burrow on the side of a swale. Five hours later after a rain, a stream of water shot for a third of a meter into the air from the hole. Red-backed voles which were trapped in freezing temperatures (minimum temperature 23°F) at Chandler Lake on August 25, 1951, were frozen solid when picked up on the trap-line in the morning.

The red-backed vole is one of the few small mammals associated with communities of mosses and lichens. As a general rule, this vole is associated with those plants giving overhead protection, such as *Cassiope,* dwarf willow and alder. Of the five species of microtines on the Arctic Slope, the red-backed vole is least dependent on the damp communities of grasses and sedges or other riparian vegetation. Red-backed voles have been trapped in association with all the kinds of small mammals on the Arctic Slope, but more commonly with the singing vole than with any of the other microtines. The cinereous shrew, singing vole, tundra vole, brown lemming and collared lemming have been taken in sets that had previously yielded red-backed voles.

On slopes of the Colville River Valley at Umiat, on August 28, 1951, the red-backed voles were trapped at the edges of stands of dwarf willow, alder and dwarf birch, especially on relatively bare soils with overhead protection. These voles occurred less frequently within the stands of trees but were trapped also in the valley where shrublike plants offered the necessary overhead protection and had relatively bare soils beneath.

From a line of traps traversing several different communities on a sidehill at Chandler Lake, this vole was more frequently trapped at the base of talus, in rock fields and especially on or at the bases of moraines which had been partially sealed with mosses and lichens, than elsewhere. Two hundred meters south of our camp at the south end of Lake Peters approximately 85 per cent of the red-backed voles trapped were taken on the first night, along a contact between a moraine and the valley. A line of traps set a week later on this contact, where the vole previously was trapped out, yielded only a few voles. This indicated some infiltration from surrounding areas. At points where caribou trails had obliterated vegetation adjoining the bases of the moraines there were only a few red-backed voles. This species wanders; one was trapped 60 meters from the usual habitat, in a community used almost exclusively by the tundra vole.

TABLE 3. SEASONAL CHANGE IN SIZE OF TESTES OF ADULTS AND SUBADULTS OF *Clethrionomys r. dawsoni* FROM SIX LOCALITIES ON THE ARCTIC SLOPE, ALASKA.

Locality and date	No.	Length of animal	Length of testis	No.	Length of animal	Length of testis
	subadults			adults		
Umiat June 30 to July 1				10	130(126-133)	11.4(10-13)
Porcupine July 13-16				6	126(124-130)	9.6(8.2-12)
Umiat July 22				1	133(133-133)	10.0(10-10)
Mount Mary Aug. 2 to Aug. 14	23	126(122-131)	3.1(2.0-4)	8	141(135-150)	12(11-14)
Chandler Lake Aug. 10 to Aug. 25	103	124(110-136)	2.6(2.0-3.5)	11	143(137-153)	6.4(4-11)
Umiat Aug. 31 to Sept. 4	20	118(114-123)	2.4(2.0-3.5)	3	136(136-137)	6.5(6-7)

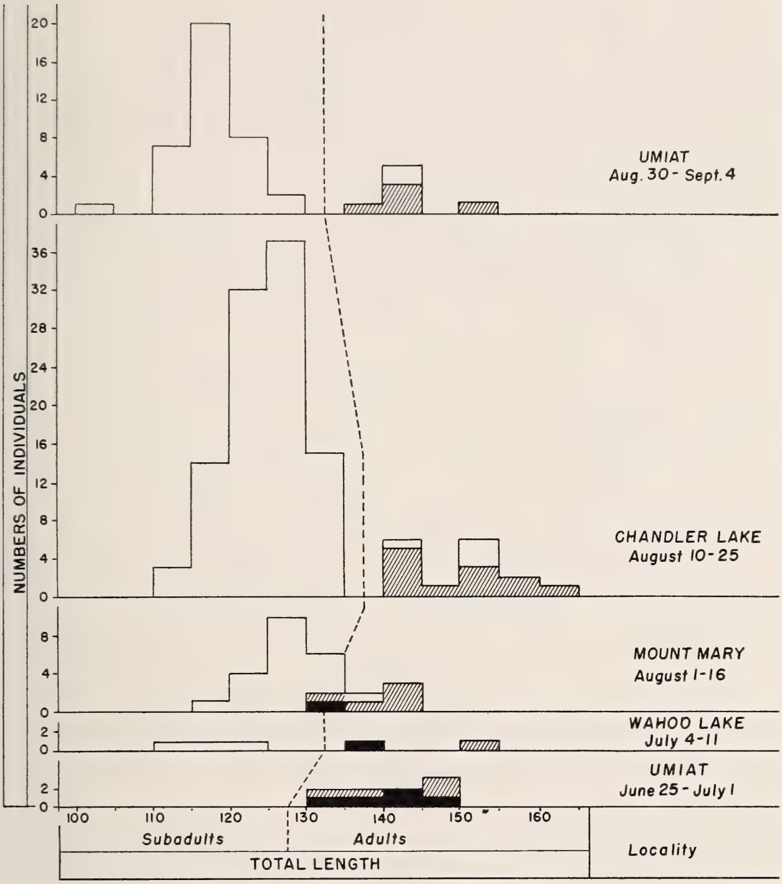


FIG. 46. Graph showing the reproductive condition of 201 females of *Clethrionomys r. dawsoni* trapped between June 25 and September 4 from five localities on the Arctic Slope of northern Alaska. Pregnant females, black; females with placental scars, shaded; females not pregnant or without visible placental scars, white. Both the adults and subadults trapped at Umiat from August 30 to September 4 are smaller than the adults and subadults trapped at Chandler Lake from August 10 to 25. Possibly the voles were born later in spring at Umiat than at Chandler Lake. If so, those from Umiat would be expected to be smaller and they are. The part of the graph for the Mount Mary area also suggests an early breeding period. The subadults of the summer generation are actually larger than the breeding adults which were born in the winter. It is to be expected that the breeding period will vary according to the stage of the cycle of fluctuation of number of each population, exposure, and weather condition on the various parts of the Arctic Slope.

Wherever damp swales or creeks penetrate rock fields, especially those associated with grasses and willows, the singing vole was associated with the red-backed vole along the contact between the swale and the rock field. Traps along the edges of swales produced about 80 per cent singing voles and 20 per cent red-backed voles.

The Eskimos say that the red-backed vole does not hibernate but is active under the snow and occasionally appears on the surface of the snow throughout the year. They believe that weasels, especially least weasels, are the principal predators of the red-backed vole.

Of 17 breeding adults from Umiat, trapped in spring between June 25 and July 1, 53 per cent were females and 47 per cent males. At Wahoo Lake (July 4-11) the ratio was 50-50. As the season advances the difference in the ratio becomes greater. At Chandler Lake, for instance, a population of 25 breeding adults, trapped from August 10 to 25, had 60 per cent females and 40 per cent males. In a sample of adults trapped late in autumn from August 30 to September 4 at Umiat, the sex ratio was 73 per cent females and 27 per cent males. The sex ratio in subadults of the summer's generation is near 50-50.

Females are larger than males. The reverse is true in the other microtines on the Arctic Slope. There is less secondary sexual difference in younger adults than in older adults and the subadults differ even less.

Five females, 133 to 149 millimeters in total length and trapped from June 25 to June 30 at Umiat, had embryos three to 16 millimeters in length (crown to rump) in sets of 4×3, 5×5, 6×3, 4×7, and 6×3. Fifty-six per cent of the females trapped at Umiat were pregnant and the remaining 44 per cent had placental scars.

In spring and summer from June 25 to August 14, testes of breeding adults average 10.8 millimeters in length whereas between August 10 and September 4, testes of adult males average only 6.5 millimeters. Testes of subadults, all born in summer, maintain throughout the summer an average of 2.7 millimeters. At Umiat on June 30, the smallest breeding adult male was 136 millimeters in total length but on September 4 the smallest one there was 126 millimeters. Judged by the average size of testes, as correlated with the time of season, the breeding cycle differs slightly at various localities.

Pelage

Four pelages are recognized in our series of 247 skins of the red-backed vole trapped from 10 localities on the Arctic Slope between June 25 and September 4: Juvenal pelage, somber and considerable gray of underfur showing through; post-juvenal pelage, dark reddish brown; pre-adult pelage, dorsal stripe brighter red, more yellow on sides and back than post-juvenal pelage; breeding adult pelage, wide dorsal stripe dark reddish brown; post-breeding pelage, like breeding-adult pelage but with addition of yellow; autumnal pelage, brownish-red dorsal stripe narrower than in breeding adult and side with more yellow; winter pelage, dull colored and red more diffused, hair long.

The underparts of the above pelages (except juvenal pelage which is dark gray) are generally light gray with a slight suffusion of buff or yellow, being more pronounced in the pre-adult pelage and autumnal pelage. Successive pelages of adult animals produce an intensification of yellow on the sides and a lighter and brighter red which is due to admixture of yellow hairs. The tail is bicolored, darker above and lighter below, and above ranges from dark brown to light buff. The dorsal stripe becomes narrower and more bicolored with increased age of the animal.

Hair in the juvenal pelage of animals from Chandler Lake is completely grown by the time the condylobasal length of the skull is 21.9 millimeters. In some individuals with a condylobasal length of 21.9 the post-juvenal pelage is starting to grow on the sides and has grown to as far as the mid-dorsal line on the back. This pelage attains its full growth at about the time the skull reaches a condylobasal length of 23.2 millimeters. Animals with skulls between 23 and 24 millimeters generally have full post-juvenal pelage. The pre-adult pelage starts in post-juvenals when the skull is as short as 23.5 millimeters and by the time the skull is 24.0 millimeters long the hair is from two to six millimeters long on the middle of the back. Some animals have nearly completed the post-juvenal pelage when the skull reaches 24.3 millimeters. No subadult skull from the Arctic Slope is longer than 24.3. The pelage changes described above occur in subadults of smaller size at Umiat. The adult females at Chandler Lake, range from 24.5 to 26.8 millimeters in condylobasal length of skull and the adult males from 24.5 to 25.9 millimeters. In the period August 10 to 25, 1951, new autumnal pelage was present in 54 per cent of the females and ranged from hair just starting on the sides to hair eight millimeters long on the middle of the back. Males, in this same period, grew hair earlier than females and 100 per cent of the males had new autumnal hair. In some of these the new hair was just beginning to grow and in others was almost completely grown.

The pattern of growth of new hair is similar to the pattern in the brown lemming. Molt occurs only between winter and breeding adult pelages and betwen autumnal and winter pelages.

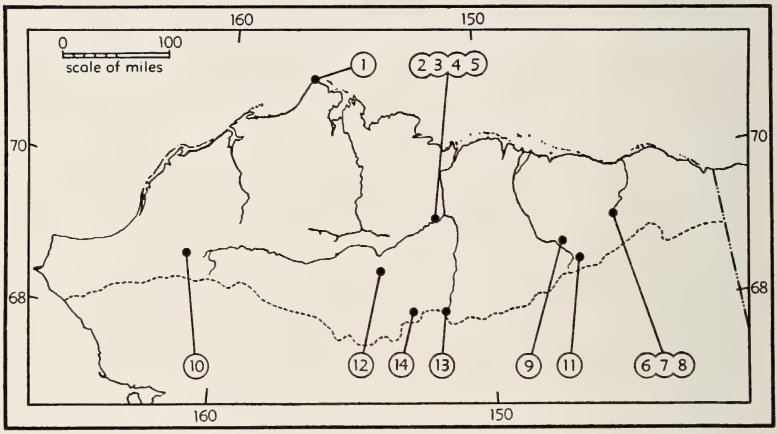


FIG. 47. Record stations of occurrence of *Clethrionomys rutilus dawsoni.*

Records of occurrence.— Specimens examined, 268: Nos. 43327-43521, 50966-51038 (Nos. 43501, 51008, 51012, 51019-51022, 51035 are skulls only and Nos. 43474, 43520, 43521 are skeletons). Specimens are distributed by localities as follows: (1) ½ mi. ESE Point Barrow, 156°35′36″, 71°18′15″, 1; (2) $1\frac{3}{10}$ mi. E and $1\frac{3}{10}$ mi. N Umiat, 152°05′30″, 69°23′12″, 350 ft., 7; (3) $\frac{9}{10}$ mi. W and $\frac{9}{10}$ mi. N Umiat, 152°10′58″, 69°22′53″, 380 ft., 8; (4) 1½ mi. W and ¾ mi. N Umiat, 152°08′10″, 69°22′18″, 370 ft., 45; (5) Umiat, 152°09′30″, 69°22′08″, 352 ft., 2 (see also Rausch, 1950b:134; 1950c: 466; 1951:182); (7) Mount Mary, S end Lake Peters, 145°10′05″, 69°20′35″, 3012 ft., 11; (8) Mount Mary, S end Lake Peters, 145°10′02″, 69°20′30″, 2920 ft., 34; (9) Wahoo Lake, 146°58′, 69°08′, 2350 ft., 5; (11) Porcupine Lake, 146°29′50″, 68°51′57″, 3140 ft., Brooks Range, 6; (14) Chandler Lake, 152°45′, 68°12′, 2900 ft., 149.

Additional records: (6) Lake Schrader (Rausch, 1951:182; 1953:128); (10) near head of Utukok River (Rausch, 1953:128); (12) [definite localities unspecified]: Circumpolar regions (True, 1884:596); Arctic regions of America (Bailey, 1898:118; Elliot, 1901:170; 1905:229); Arctic America (Trouessart, 1904:443); throughout . . . mainland of Alaska (Orr, 1945:70); [Arctic Slope] (Burt and Grossenheider, 1952: map on p. 123); (13) Tolugak [Tulugak] Lake (Rausch, 1950b:134; 1950c:466; 1951:182).

Microtus oeconomus gilmorei Setzer

Tundra Vole (Avingak)

Microtus oeconomus gilmorei Setzer, Proc. Biol. Soc. Washington, 65:75, April 25, 1952, type from Point Lay (163°04′ W long. and 69°46′ N lat.), Alaska. (Also Hall and Cockrum, 1953:424.)

Arvicola riparius borealis, Nelson and True *in* Arctic Ser. No. 3, issued in connection with Signal Service, U. S. Army, pp. 275, 276, 1887.

Microtus operarius endoecus, Hall, Univ. California Publ. Zool., 30:424, March 19, 1929.

Microtus oeconomus macfarlani, Rausch, Jour. Washington Acad. Sci., 40:135, April 15, 1950. (Also Rausch, 1950c:466; 1951:182; Barkalow, 1952:199.)

Microtus oeconomus, Burt & Grossenheider, Field guide to the mammals, Houghton Mifflin Co., Boston, p. 127, 1952.

Microtus oeconomus endoecus, Rausch, Arctic, 6:129, July, 1953.

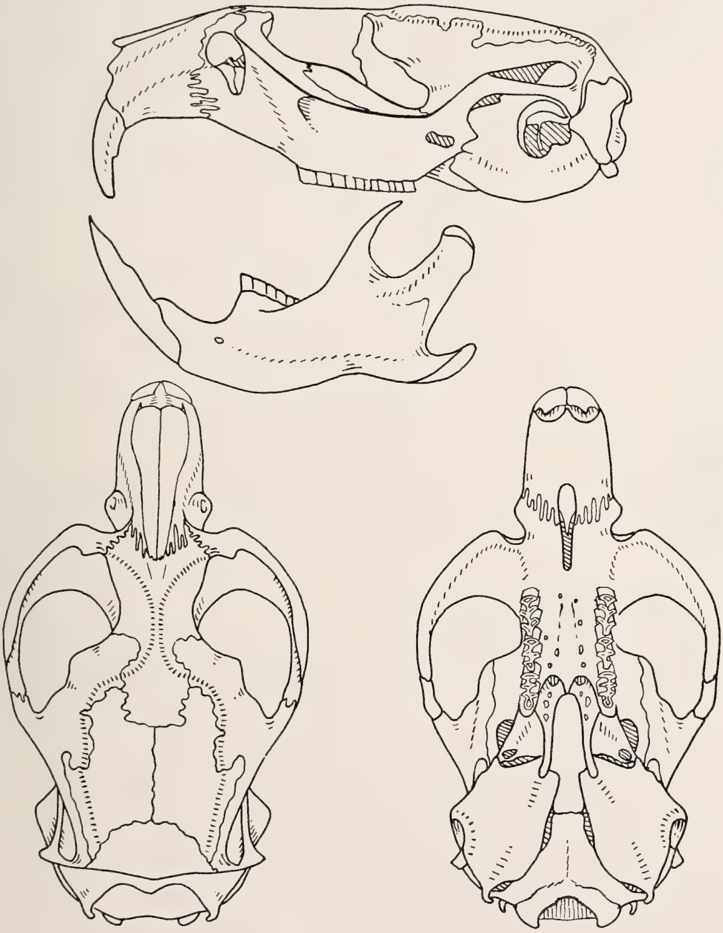


Fig. 48. Skull of *Microtus oeconomus gilmorei,* 1½ mi. W and ¾ mi. N Umiat, 69°22′18″, 152°08′10″, 370 ft., August 30, 1951, No. 43536 KU, ♀. × 2½.

Description.—See colored frontispiece. Average and extreme measurements of 42 adult males and 64 adult females from within 2½ miles of Umiat, trapped in June, July, August and the first part of September, are as follows:

Total length, ♂ 165(150-185), ♀ 159(149-176); tail, 42.6(38-54), 42(33-51); hind foot, 19.6(19.5-21), 19.3(18-21); ear from notch, 12.1(11-13), 11.9(10-14); condylobasal length, 28.8(27.4-30.6), 27.5(26.1-29.2); length of nasals, 7.8(7.0-8.5), 7.5(6.8-8.4); zygomatic breadth, 16.1(14.6-17.3), 15.3(14.1-16.4); interorbital breadth, 3.7(3.4-4.1), 3.7(3.3-3.9); alveolar length maxillary tooth-row, 6.8(6.4-7.6), 6.6(6.0-7.0); palatilar length, 13.7(12.9-14.4), 13.2 (12.7-14.1); mastoid breadth, 11.0(10.0-11.8), 10.7(10.2-11.3); diastema, 8.8(8.2-9.8), 8.5(8.0-9.2); width between medial edges of supratympanic fenestrae, 8.7(8.0-9.3), 8.8 (8.2-9.5); width between anterior edges of auditory meati, 12.9(12.0-14.0), 12.6(11.7-13.4); width between posterior edges of auditory meati, 12.2(11.4-13.2), 11.9(11.1-12.6); width across lambdoidal crest, 12.7(11.9-13.7), 12.1(11.1-12.8); weight, 58(39-80), 47(29-65) grams. Pelage of upper parts of adult males from Umiat are as follows: Breeding pelage (51391) near (15′*n*) Prout's Brown; post-breeding pelage (43551) near (13 *n*) Argus Brown; autumnal pelage (43579) near (13 *l*) Amber Brown; winter pelage (51343) near (15′ *j*) Ochraceous-Tawny. Underparts of above

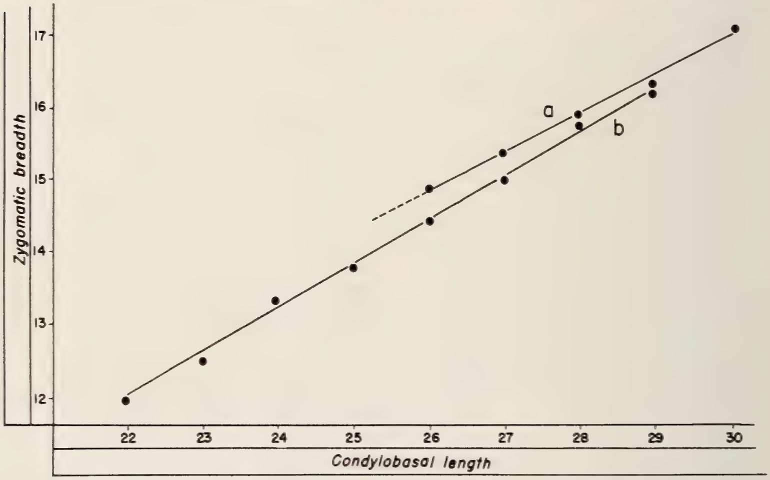


FIG. 49. Regression lines showing condylobasal length of skull (group data) plotted against the zygomatic breadth of skulls of 138 individuals of both males and females of *M. o. gilmorei* trapped at Umiat. Measurements are in millimeters. Line *a* represents individuals born in the winter or late fall of the previous year and trapped from June 25 to June 30. The skulls of this group are relatively wide and are mature in appearance. Line *b* represents individuals born in late winter, spring, or summer of the previous year and trapped from August 30 to September 3. The skulls of this group are relatively narrow, and are less mature in appearance when compared to skulls of equal length in line *a*. The difference between the two seasonal groups of skulls is greatest in younger animals and least in older adults. To recognize geographic variation in northern Alaska, it is just as important to take into consideration this seasonal variation in size and shape of the skull as it is to take into consideration variations in pelage that reflect seasonal and age variation. Factors that control changes of pelage almost certainly influence the growth of bone.

pelages near (15′ g) Pale Ochraceous Buff except underparts of winter pelage which are grayish white with faint wash of buff; tails above blackish brown, below like underparts but with darker buff; upper parts of hind and forefeet grayish white with wash of buff; soles naked; hairs dark plumbeous at base. Post-juvenal and pre-adult like autumnal pelage of adult; juvenal like breeding pelage of adults but darker because of plumbeous part of hair exposed; upper parts of feet blackish.

Remarks.—M. o. gilmorei from the Arctic Slope differs from *M. o. endoecus* from the south side of the Brooks Range (specimens from Bettles) in smaller size; lambdoidal crest more developed and extends farther beyond posterior edge of auditory meatus; lacrymal and frontal protuberances sharper; interorbital ridge more pronounced; zygomatic arches thinner; sculpturing of frontals and parietals slightly deeper; pelage paler. Size of animals on the Arctic Slope is uniform from east to west but decreases from north to south. Specimens from Meade River are the largest that we have from the Arctic Slope and approach in size those from Bettles south of the Arctic Slope.

The tundra vole on the Arctic Slope seems to have been isolated from those in the Yukon drainage at the time glaciers filled the low valleys in the mountains during the last glacial optimum. Probably there has not been sufficient time since these glaciers disappeared from the valleys, nor proper conditions on the low divides between the headwater drainage systems, to permit much free gene-flow between populations of voles on the north and south sides of the Brooks Range.

The tundra vole occurs over all of the Arctic Slope except possibly in a strip 50 miles wide along the ocean. There, between Point Lay and Barter Island there are no records. Intensive search in the proper habitat may reveal that the species occurs also in this coastal strip.

The tundra vole prefers extensive flat areas. In the Brooks Range and Plateau Province the vole, for the most part, has a dendritic distribution; it occurs in areas made by streams. On upland tundras this vole lives around lakes and marshes. The holding capacity of the soil in the Arctic creates marshes and wet meadows in a variety of places not directly associated with the river courses or the edges of lakes. On the Coastal Plain, the vole is associated with stream courses, and stabilized shore lines of lakes and extinct lake beds that now are sealed in with sedges.

This vole prefers moist areas, or even wet areas, where the water level is constant or fluctuates only slightly. Voles were caught in a marsh at the south end of Chandler Lake, but a strong north wind on the next day made the water there 20 centimeters deeper and the voles probably took refuge on the sidehill 20 meters away. Next day the waters subsided and tundra voles again occupied trails. In the change of weather from summer to autumn on August 14, 1951, at Chandler Lake, the water gradually rose and excluded these voles from places used by them in summer; the voles took refuge on fracture ridges and hummocks of vegetation. Heavy precipitation and lack of evaporation in cloudy weather raise the level of lakes and streams and cause the voles to make minor adjustments. In autumn and winter when water freezes in marshes

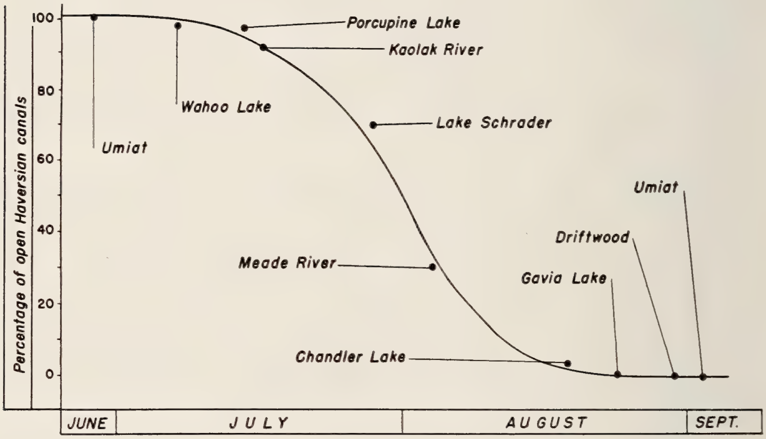


FIG. 50. Graph showing the percentage of open Haversian canals on the maxillary arms of the zygomata of 320 skulls of *M. o. gilmorei,* trapped between June 25 and September 3, 1951-52, from nine localities on the Arctic Slope. As there is no significant difference between males and females as to the time when the Haversian canals close, the two sexes are combined for analysis. In spring, every skull has open canals but in autumn every skull has the canals closed except that in some young animals, the skulls of which measure approximately 24.5 mm or less in condylobasal length, the canals are open. Occasionally, however, skulls measuring 24.2 mm in condylobasal length have the Haversian canals closed especially in animals trapped in late autumn. Parts of the skull, especially the zygomata, increase in size in spring and summer as a result of the formation and activity of new Haversian canals on the surface of the bone. This accentuated growth of the skull in spring and summer explains the relatively large and elongate skulls of young animals born in spring. The inhibiting factors of the climate and food of winter are responsible for the dwarfed skulls that are produced, or that undergo at least most of this development, in winter. The change of season, from summer to autumn, initiates the closing of the canals of all microtines on the Arctic Slope regardless of sex, age (except juveniles) or species.

and there is a protective layer of snow, tundra voles eat aquatic plants that are unavailable in summer because the plants grow in relatively deep water.

In wet meadows and marshes where this vole lives, sedges (mostly carices), and grasses are the principal plants. At Chandler Lake the dominant plant in the low, wet community used by the tundra vole was *Carex aquatilis* Wahl. Other carices were dominant in the deeper waters and along permanent and running water. The subdominant was *Arctogrostis latifolia* (R. Br.) Griseb. Associated plants were *Carex physocarpa* Presl., *C. lugens* Holm, *C. Kelloggii* W. Boott, *C. podacarpa* R. Br., *Poa arctica* R. Br., *Poa glauca* Vahl, *Festuca scabrella* Torr., *Calamogrostis neglecta* (Ehrh.) Gaertn. Meyer and Schreb. inter. with *C. purpurascens* R. Br. and *Trisetum spicatum* (L.) Richt.

The brown lemming and tundra vole occur together; they eat the same kind of food and use the same kinds of nesting places. In the marshes of the southern part of the Arctic Slope the tundra vole is the major influent whereas in the northern part of the Arctic Slope, where the brown lemming is common, the tundra vole is a minor influent. All the kinds of small mammals that occur on the Arctic Slope have been trapped in communities dominated by the tundra vole.

At Umiat on the Colville River in the latter part of August, 1951, 98 per cent of the tundra voles that we trapped were in marshes and wet meadows of carices and grasses below alluvial slopes. A few voles were trapped on the sides of the valley. The optimum conditions for the voles were in soil polygons where the bordering elevations allowed burrowing and provided refugia when sedges and grasses in the low parts of the polygons were inundated. Soil ridges were deeply furrowed with runways made originally, perhaps, by brown lemmings at times when they were abundant but maintained at other times by tundra voles.

Among mammals of a given community the one species slightly better adapted to it than the several other species tends to force the others to marginal areas. Results of our trapping in 1952 between June 26 and July 2, at Umiat provided evidence supporting this generalization. Tundra voles were trapped in three areas as follows: 1) From around the base of masses of soils which had been pushed onto the wet meadows of marsh grasses in the construction of the airstrip (45 tundra voles, one brown lemming, three singing voles and one red-backed vole); 2) from a marsh of grasses and sedges on the bench-land near the mouth of Bearpaw Creek (39 tundra voles and two brown lemmings); 3) from the side of the valley northwest of Umiat in three communities, which were closely grouped, a) grasses and sedges along a lake, b) willows on an alluvial plain, and c) dry slopes supporting dwarf birch and *Vaccinium vitis-idea* (10 tundra voles, 16 singing voles, eight red-backed voles and two brown lemmings). In area No. 3, each mammalian species was in the place best supplying its needs. For instance, tundra voles and brown lemmings were in the grasses and sedges along the lake, red-backed voles were in the willows on the alluvium, and singing voles were on dry slopes above the lake. The highest percentage of tundra voles trapped on the Arctic Slope was at Umiat in the latter part of August of 1951; 11 were taken along with six red-backed voles (in marginal areas), and one brown lemming in a marsh of sedges and grasses broken by polygons. One least weasel also was taken in this trap-line.

A line of 60 traps was set on the edge of a continuous shore line at Gavia Lake on August 21, 1952. This shore line was an eroded bank supporting grasses, sedges and willows which under normal conditions would have been suitable for either the singing vole or tundra vole. One part of the bank was three meters high and the other part only one-third to two-thirds of a meter. Along the high part of this bank we trapped only singing voles (13 in 30 traps) and from the low part only tundra voles (16 in 30 traps). Neither species overlapped the other. It seemed that there was an insufficient food supply for both species and the one best adapted was dominant. At the edge of an oxbow lake in the same general area tundra voles were trapped along the base of the bank supporting many grasses and sedges, and singing voles were trapped two meters away on the upper parts of the bank which supported many willows. This area differed from the shore line along Gavia Lake only in the relative amount of grasses and willows in the community. Subadults of the singing vole and the tundra vole taken from the banks of these oxbow lakes constituted 66 and 60 per cent, respectively, of the total population.

Tundra voles prefer marsh areas that are extensive and continuous, but some of these voles were trapped in localized areas of sedges and grasses around the edge of Wahoo Lake from July 4 to 11, 1952.

At the west end of Porcupine Lake between July 13, and July 18, we trapped the tundra vole from wet meadows bordering the deeply eroded outlet of the stream that drained the lake. This stream varied at different seasons from one-third to three meters in width and from one centimeter to one meter in depth. In early spring this stream overflowed and saturated adjoining meadows of grasses and sedges used by the tundra vole. In meadows, fissures in the soil are filled with water when rains come. These fissures are used as the principal runways in rainless periods. Plant communities that we examined on alluvium of creeks entering the main canyon seem to be ideal for small mammals but in rains the grasses, mosses and lichens become inundated to a depth of as much as three-fourths of a meter by flood waters from the creeks. Water increases in volume in these creeks and is at its maximum level two days after the rains have stopped.

At Driftwood (August 28-31, 1952) the tundra vole lived in wet marshes and meadows of the river valley, especially on the first erosional benches above the present river course, where the older stream and overflow channels were stabilized and sealed in with grasses and sedges and other vegetation. Wherever such areas of grasses and sedges lead into the willow community of the singing vole, it excludes the tundra vole.

From grasses and sedges on the soil polygons of the stabilized alluvium (which almost separates Lake Peters from Lake Schrader) we trapped (July 24-25) 26 tundra voles and 68 brown lemmings in two consecutive nights. On the third consecutive night only one tundra vole and three lemmings were caught in the same line of traps. Trapping in this same area three days later yielded no evidence of infiltration of either the lemming or tundra vole. As shown by the initial trapping these two species were closely associated and sometimes shared the same runways. The tundra vole, nevertheless, was more frequently taken in the wet runways in the centers of the polygons whereas the brown lemming was more frequently taken on the bordering ridges. The tundra vole was not trapped on the high dry raised polygons inhabited by the singing vole, although in some instances these raised polygons were no more than a meter away. No tundra voles were trapped at the south end of Lake Peters. There, wet meadows were in more direct contact with communities in which the singing vole and the red-backed vole were major influents than were the polygons on the alluvium between the two lakes.

Several dead tundra voles in traps set in a marsh at Lake Schrader had been partly eaten by their own kind or by the brown lemming. Fur and flesh had been torn from the head, neck and anterior part of the back.

At Chandler Lake on August 18, 1951, several tundra voles were thrown into the lake to determine whether they would be eaten by lake trout. A trout (*Cristovomer namaycush*) caught a few hours later had in its stomach a tundra vole, swallowed tail first. Trout were attracted by the carcasses. A lake trout passed by approximately every four minutes in water only 150 millimeters deep.

Caribou travel along the bases of hills and on the floors of canyons and most communities of the tundra vole are affected by trampling of caribou. Trails made and maintained by caribou can destroy a meadow or marsh on a sidehill by channeling of water. If the furrows are horizontal they hold water and eventually create a marsh. Vegetation in some marshes, which are in the direct path of migrating caribou, is completely trampled down.

The densest populations of the tundra vole are on soils that have been pushed (for example by a bulldozer in construction of airstrips and roads) onto marshes or wet meadows. This was the case also on the south side of the Brooks Range, in the timbered country, at Bettles. In such instances the voles of a large area seem to crowd into a small one; concentration of men and planes cause carnivores to desert the area of an airstrip, and predation is reduced; other kinds of microtines seem to be kept out temporarily by inhospitable marshy areas.

At Chandler Lake on August 21, 1951, vegetation on dry sidehills changed from green of summer to yellows and reds of autumn, but color of the grasses and sedges in the tundra vole's habitat changed little or none. Perhaps the tundra vole has a source of vitamins in these green plants for a longer time than do microtines of other habitats in the general area. On the above date, the end of the growing season at Chandler Lake, dry grass-stems of the preceding year's growth were 500 millimeters high, 200 millimeters higher than stems of the current year growing out of the same base. It seems that there was a better growing season in 1950. Bush pilots stated that 1951 was notable for rain and cloudy weather. The more favorable weather, in 1950, may have been responsible for the dense population of microtines in this area. Fluctuation in the plant growth may determine fluctuations in the small mammals.

Nests and Runways

Nests are made in chambers dug by these voles in shallow soils or fracture ridges surrounding marshes. A chamber, depending on its size, may serve also as a storage place for food. Old underground runways also are used for storage. On July 21, 1952, Ira L. Wiggins found *Polygonum viviparum* growing from rhizomes which had been stored in shallow subterranean corridors in fracture ridges by a vole, probably of this species. At Porcupine Lake a tundra vole held by the hind leg in a trap made a surface nest, 150 millimeters wide and 100 millimeters high, of green grasses. This nest protected the vole from rain.

Interconnecting runways in marshes usually connect with runways on higher ground surrounding the marshes or with runways on fracture ridges or elevations within the marshes. The trails are maintained and regularly used, at least in summer. Mounds of fecal pellets at the intersections of the runways are typical of these systems of the tundra vole.

Twice at Porcupine Lake we saw a tundra vole (once an immature) swim across a rain-filled channel which, when dry, was part of a continuous runway connecting the marshes on either side of the channel.

Reproduction

The average number of embryos in the right and left uteri and the average size of embryos (crown to rump) of 91 females of *M. o. gilmorei* from various localities on the Arctic Slope are as follows:

3.9 × 3.9	10.9 mm	Umiat	(39)	June	25-31
4.0 × 3.9	5.2 mm	Wahoo Lake	(15)	July	4-11
3.5 × 3.6	7.5 mm	Porcupine Lake	(15)	July	13-15
3.7 × 3.4	13.0 mm	Lake Schrader	(18)	July	24-30
3.0 × 3.5	16.0 mm	Chandler Lake	(2)	August	10-25
2.0 × 3.0	17.0 mm	Gavia Lake	(2)	August	21-23

The number of embryos carried in the uteri gradually decreases from an average of 7.8 in late June to 5.0 in late August. The number in 91 sets of embryos averaged 3.8 in the right uterus and 3.7 in the left; but the difference probably is not significant. The extremes in numbers of embryos in the uteri of one female are 4 × 7, 2 × 9, 0 × 6, and 2 × 1. The largest embryo, which measured 20 millimeters from crown to rump, was from a female 165 millimeters in length.

In the latter part of June (June 25-31 at Umiat) the sex ratio of a population of 117 voles was 52 per cent females and 48 per cent males. By the end of the summer in the latter part of August and the first part of September (Umiat, August 29 to September 3) the sex ratio of 39 adults was 80 per cent females and 20 per cent males. This decrease in males probably results from predation on males, which are more active on the surface of the ground than are females. Voles born in spring maintain a 50-50 sex ratio throughout the summer and autumn and presumably throughout the winter; the emerging population in spring has a 50-50 ratio.

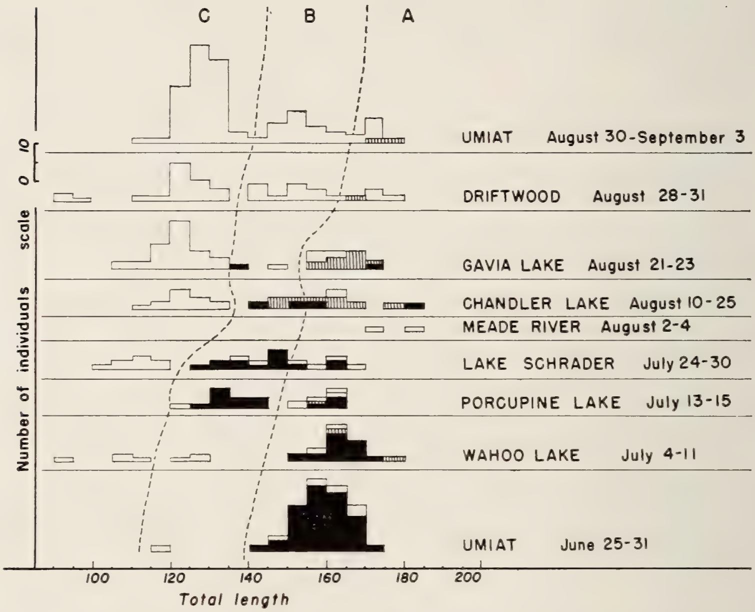


FIG. 51. Graph based on females of *M. o. gilmorei* trapped from June 25 to September 3 in the years 1951 and 1952 from several localities on the Arctic Slope showing the relative percentages of pregnant females (black), females with placental scars (shaded) and females with normal uteri (white). Three age groups are represented: *a.* adults born early in the winter, *b.* adults born early in the spring, and *c.* subadults born after July 4. Breeding adult females usually have only one litter. The older females born in the summer and autumn of the previous year breed earlier than the females born in the winter. We have no information that the young born in the spring breed in the summer or autumn of the first year. Females at Bettles on the south side of the Brooks Range have young earlier than do females on the Arctic Slope.

Pelages

An animal born in spring and living into its second autumn passes through juvenal, post-juvenal, pre-adult, winter, breeding, post-breeding and autumnal pelages. The sequence of molting and growth of new hair are the same as in the singing vole and the brown lemming. Hair is molted between winter and breeding pelages and between autumnal and winter pelages. In all other pelages the older hair remains in place and the new hair grows through the existing pelage.

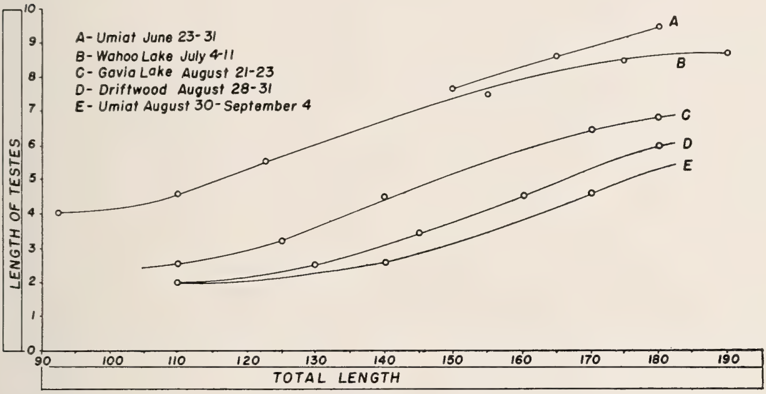


FIG. 52. Regression lines showing length in millimeters of testes plotted against total length of individuals of *M. o. gilmorei.* These animals were trapped at different times in the summers of 1951 and 1952 from several localities on the Arctic Slope of Alaska. Adult males, trapped from June 23 to 31, have the largest testes and are just past the period of greatest breeding activity. Testes of animals trapped from August 30 to September 4 show a regression in size of more than 50 per cent of animals trapped from June 23 to 31. The periods between June and September show a gradual decrease in size of testes.

Records of occurrence.—Specimens examined, 381: Nos. 43532-43536, 43538-43569, 43573-43595, 43597-43600, 43602-43645, 51281-51293, 51295, 51296, 51298-51309, 51311-51313, 51315-51318, 51321, 51422, 51424, 51426-51433, 51435-51437, 51439-51453, 51455-51471, 51473-51512, 51514-51547; skulls only, 43537, 43601, 51294, 51297, 51314, 51319, 51320, 51423, 51425, 51438, 51454, 51513; skeltons, 43570-43572, 43596, 51434, 51472; skin only, 51310. These are distributed by localities as follows: (2) Meade River, 50½ mi. S and 9 mi. W Point Barrow, 156°30′53″, 70°39′30″, 40 ft., 3; (4) Kaolak River, 159°47′40″, 70°11′15″, 30 ft., 2; (5) Kaolak, 160°14′51″, 69°56′00″, 178 ft., 1; (7) Gavia Lake, 150°00′, 69°35′, 460 ft., 43; (8) Spawning Creek, W side Lake Schrader, 145°11′40″, 69°25′08″, 2908 ft., Brooks Range, 2; (9) Lake Schrader, 145°09′50″, 69°24′28″, 2900 ft., 26 (see also Rausch, 1953:129); (12) Bearpaw Creek, $1\frac{7}{10}$ mi. E and $1\frac{7}{10}$ mi. N Umiat, 152°04′50″, 69°23′30″, 550 ft., 5; (13) $1\frac{3}{10}$ mi. E and $1\frac{3}{10}$ mi. N Umiat, 152°05′30″, 69°23′12″, 350 ft., 16; (14) $\frac{9}{10}$ mi. W and $\frac{9}{10}$ mi. N Umiat, 152°10′58″, 69°22′53″, 380 ft., 15; (15) 1½ mi. W and ¾ mi. N Umiat, 152°08′10″, 69°22′18″, 370 ft., 73; (16) Umiat, 152°09′30″, 69°22′08″, 352 ft., 53 (see also Rausch, 1950c:466; 1953:130); (18) Wahoo Lake, 146°58′, 69°08′, 2350 ft., Brooks Range, 30; (20) 2 mi. W Utukok River, 161°15′30″, 68°54′50″, 1275 ft., 3; (21) Driftwood, Utukok River, 161°12′10″, 68°53′47″, 1200 ft., Brooks Range, 41; (24) Porcupine Lake, 146°29′50″, 68°51′57″, 3140 ft., Brooks Range, 30; (27) Chandler Lake, 152°45′, 68°12′, 2900 ft., 38.

Additional records: (1) on river, fifty miles south of Barrow (Hall, 1929: 424; Hall and Cockrum, 1953:424); (3) Barter Island (Barkalow, 1952:199, 201); (6) Point Lay (Setzer, 1952:75; Rausch, 1953:130; Hall and Cockrum, 1953:424); (10) Lake Schrader (Rausch, 1951:182; 1953:129); (11) mouth of Chandler River (Setzer, 1952:75); (17) Umiat (Rausch, 1950b:135, 1950c: 466; 1951:182; Setzer, 1952:75; Rausch, 1953:130; Hall and Cockrum, 1953: 424); (19) barren ground S from [Cape Thompson to the international boundary] (Bailey, 1900: 39); [Arctic Slope] (Burt and Grossenheider, 1952: 128); (22) Utukok River, 200 mi. SW Point Barrow (Setzer, 1952:75; Hall and Cockrum, 1953:424); (23) Cape Lisburne (Nelson and True *in* Nelson, 1887:275); (25) Killik River [definite locality unspecified] (Rausch, 1951: 182; Setzer, 1952:75; Hall and Cockrum, 1953:424); (26) Tolugak [Tulugak] Lake [151°26′ W, 68°24′ N, near head Anaktuvuk River Valley, Brooks Range] (Rausch,1950c:466; 1950b:135; 1951:182); (28) Anaktuvuk Pass region (Setzer, 1952:75; Rausch, 1953:130; Hall and Cockrum, 1953:424; (29) [Cape Thompson] to Cape Lisburne (Nelson and True *in* Nelson, 1887:233, 275).

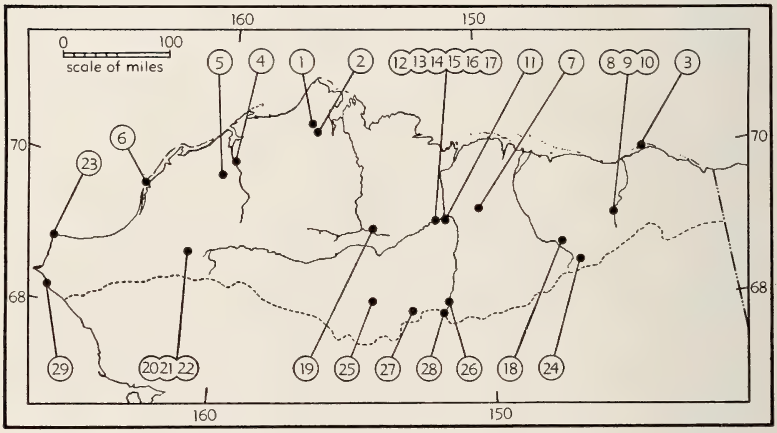


FIG. 53. Record stations of occurrence for *Microtus oeconomus gilmorei.*

Microtus miurus muriei Nelson
Singing Vole (Avingak)

Microtus muriei Nelson, Jour. Mamm., 12:311, August 24, 1931, type from Kutuk River (tributary of Alatna River), Endicott Mountains, Alaska.

Microtus miurus paneaki Rausch, Jour. Washington Acad. Sci., 40:135, April 21, 1950, type from Tolugak [Tulugak] Lake (lat. 68°24′ N, long. 152°10′ W), Brooks Range, Alaska. (Also Rausch, 1950c:466; 1951:183.)

Microtus miurus muriei, Hall and Cockrum, Univ. Kansas Publ., Mus. Nat. Hist., 5:312, November 17, 1952. (Also Rausch, 1953: 134.)

Description.—See colored frontispiece. Average and extreme measurements of 31 males and 29 females, all breeding adults, taken from July 4 to 9, 1952, at Wahoo Lake, are as follows: Total length, ♂ 155(147-161), ♀ 147(134-161); length of tail, 30(21-35), 29(25-32); length of hind foot, 20(19-21), 19(18-21); height of ear from notch, 13(11-14), 13(11-14); weight, 48(40-60), 43(30-52) grams. Weights of females all are of non-pregnant individuals. In breeding-adult pelage(for example, ♀ 51065, June 30, from Umiat), upper parts near (*j*) Buffy Brown (colored part of individual hair mostly light buff; underparts near (*e*) Pale Smoke Gray to Deep Olive Buff; sides tawny but grading gradually into Clay Color anteriorly and posteriorly and into color of underparts ventrally; postauricular patches Light Ochraceous Buff to Clay Color; feet gray to pale buffy; tail deep buff above, pale buffy below. In late summer pelage (♀ 43744, September 3, from Umiat), upper parts near (*j*) Dresden Brown (colored parts of individual hairs near (16′ *g*) Light Buff to near (16′ *l*) Dresden Brown); underparts gray to Deep Olive Buff; sides near (*a*) Clay Color grading gradually into color of underparts; postauricular patches Sudan Brown to Clay Color; feet Light Ochraceous Buff; tail above like upper parts, Clay Color below. Winter-adult pelage paler and grayer. Color of pre-adult pelage closely resembling that of adults.

"Greenish-yellow" color of pelage (see frontispiece), narrow skull (fig. 54) and distinctive enamel pattern of molar teeth (fig. 16 *e-e′*) serve to differentiate this species from each of the four other species of microtine rodents that occurs on the Arctic Slope.

Remarks.—In intensity of brown in the pelage there is a cline from east to west; the brown is most intense at the west. The darkest of our specimens are from Driftwood, No. 51250 being an example. This specimen is not so brown as the lightest of the specimens examined by us from the Seward Peninsula.

In the Brooks Range the singing vole is the most abundant microtine. On the Plateau Province, this vole is confined to a habitat of limited extent and is less common than other microtines. We have only two records of the singing vole from the low Coastal Plain.

Speaking now of only the Brooks Range, the vole lives on the slopes above the floors of canyons, the precise places being determined by degree of drainage. There the vole is partial to, and becomes most abundant on, relatively dry soils (sandy or deep soils) which are well drained and near running water. This vole is seldom flooded out but a few lived in marginal areas where water collected to a depth of two-thirds of a meter. These voles retreated to higher ground or took refuge on "islands" of grass at the edges of trails made by caribou. The densest populations are on the benchlands dissected by permanently flowing tributaries of the main stream. The singing vole is most numerous on areas dry enough for willows to grow there. Areas that are periodically inundated are used for foraging areas when they are dry. Another preferred habitat is dry soil alongside narrow but steep (20 to 40 degrees in grade) swales in which running water is confined to small channels approximately 30 millimeters deep and 400 millimeters wide. Such channels shift their courses back and forth across the swales and, depending upon the substrate, are intermittent. Burrows, dug at the edges of the swales, frequently are flushed out by water under hydrostatic pressure. At a distance, such

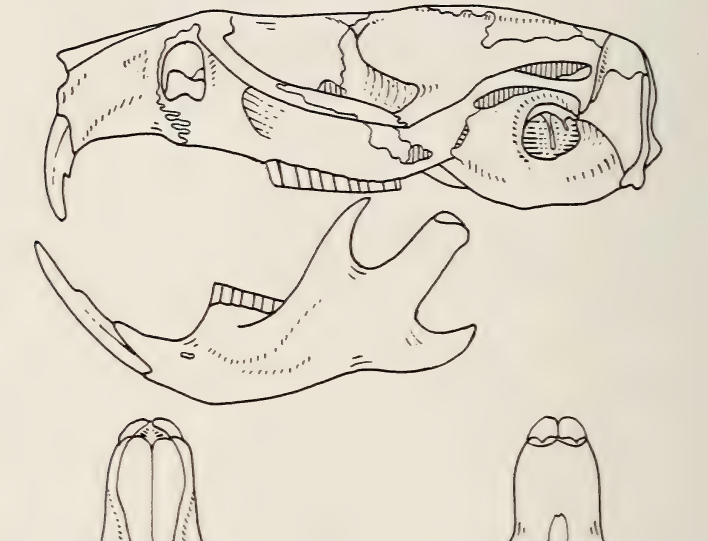


FIG. 54. Skull of *Microtus miurus muriei*, 9/10 mi. W and 9/10 mi. N Umiat, 152°10′58″, 69°22′53″, 380 ft., July 1, 1952, No. 51065 KU, ♀. ×3.

swales on the side of a canyon show up as green in contrast to the surrounding drab-colored vegetation. Occasionally shallow depressions which support willows are used, but in autumn when water fills these depressions they are abandoned by the voles. Stabilized parts of alluvial fans at the south end of Lake Peters and the edges of old stream channels which cross these fans are extensively used throughout the year. However, these habitats are short-lived. In typical, high, intermontane valleys in the Brooks Range (at Wahoo Lake and Porcupine Lake), the singing vole inhabits four types of terrain: 1) shores of lakes where they are eroded from wave action and from the trampling of caribou; 2) high steep banks of creeks; 3) steep swales; and 4) soils supporting high hummocks.

TABLE 4. CRANIAL MEASUREMENTS, IN MILLIMETERS, OF 31 MALES AND 29 FEMALES OF *Microtus miurus muriei*, ALL IN BREEDING—ADULT PELAGE, FROM WAHOO LAKE, COLLECTED JULY 4 TO JULY 9, 1952, AND THE LARGEST INDIVIDUAL COLLECTED ON THE ARCTIC SLOPE (MOUNT MARY, S END LAKE PETERS, AUGUST 14, 1952).

	Condylobasal length	Occipitonasal length	Length of nasals	Palatilar length	Zygomatic breadth	Mastoid breadth	Greatest width of braincase	Distance between supratympanic fenestrae	Interorbital breadth	Width of rostrum	Alveolar length of upper molar tooth-row	Palatofrontal height
av. (♂)	27.9	27.3	7.3	13.5	14.2	10.6	12.1	8.7	3.3	5.4	6.2	7.3
min.	26.8	26.3	6.6	12.6	13.3	9.8	11.5	8.0	3.1	5.0	5.9	6.9
max.	28.9	28.3	7.8	14.2	15.0	11.2	12.7	9.2	3.5	5.8	6.8	7.8
av. (♀)	27.0	26.6	7.1	13.2	13.7	10.4	11.7	8.7	3.3	5.2	6.3	7.0
min.	25.4	24.8	5.9	12.1	12.5	9.8	10.7	8.0	3.0	4.5	6.0	6.4
max.	28.2	28.0	7.6	14.1	14.4	10.9	12.5	9.3	3.6	5.9	6.6	7.6
largest individual	31.0	29.6	8.5	15.4	16.5	11.8	13.1	9.3	3.8	6.5	7.3	8.6

On the Plateau Province, at Umiat, the singing vole lives principally on the steep sides of the Colville River Valley in places that are in early stages of plant succession. At Driftwood, farther west, this vole lives in the river valleys that are being formed in undulating uplands. Areas frequently occupied are the dry bottomland adjacent to cut banks of the river, the higher, horizontal parts of the first "bench" and third, corresponding parts of successively higher benches. The densest populations are on islands made by the waters of the braided rivers. These islands support waist-high willows with a sparse growth of understory plants on the relatively dry soils. In periods of high water many of these islands are inundated. The tops of the banks of the river are flooded less often—probably only in spring. The next higher bench is rarely if ever flooded. The voles are most numerous in the least permanent habitat, in early seral stages.

On the low Coastal Plain (at Gavia Lake) the vole is confined to land adjoining steep banks, rarely more than three meters high, along shores of lakes and oxbows.

The singing vole is active in the day, especially when the sky is overcast, as well as at night; individuals were seen foraging in light rains and in snowstorms when temperatures were below freezing. The time of transition between autumn and winter, with low temperatures and strong winds before the ground is covered with snow, is critical. Slopes blown free of snow in winter are not inhabited by the vole.

The association of the dwarf willow and the singing vole is general on the Arctic Slope, especially where there is an understory of mosses, lichens and forbs. Other vegetation of growth habit similar to that of the dwarf willow may be used. The singing vole is less dependent on grasses and sedges than are the other microtines, except for the red-backed vole. Nevertheless, the singing vole has been taken in dense grasses and sedges 300 millimeters high. This vole seldom lives along creeks where willows are too high or are poorly developed overhead; the individual willows must be so spaced as to promote growth of the understory vegetation on which the vole depends for food.

Boulder fields that are sealed in with mosses and lichens are used only when herbaceous plants are available nearby. Subsurface runways or trails sunken into the surface of the mosses and lichens are used. Low wet meadows of sedges and grasses are seldom visited except when the meadows are bordered by willows or shrubs of the required growth form. At high elevations the absence of required vegetation probably is the limiting factor for this vole.

Isolated individuals of the singing vole were in some areas where there seemed to be no other microtines. In other places groups of singing voles were closely associated with all the other kinds of mammals in the general area.

The singing vole builds forage piles, sometimes to an extent that importantly affects its plant and animal associates. In autumn, forage piles usually are built under dwarf willow and other shrublike plants; at this season, low temperature accompanied by snow, and sometimes by rain, provides the stimulus that causes a singing vole to begin construction of a forage pile. Only green vegetation is used; it is spread in a layer and allowed to cure and then another layer is added and cured. The resulting pile is green but dry enough not to mold.

At Lake Peters, from August 10 to 15, 1952, the most active periods of building forage piles were before and after the first snows. Two piles that were closely observed were constructed in two days; one was approximately a gallon in volume and the other three quarts. The vegetation in these piles was not cured by exposure to wind and sun. During this same period in an area 10 by 13 meters, each of thirteen individuals was actively building a separate forage pile. In the six days the piles progressed approximately one-third of the way to completion. At Chandler Lake the building of forage piles began on or about August 5, and by August 14, this activity had reached a maximum. At Gavia Lake during the night of August 20, 1952, singing voles built forage piles while a light snow storm was underway; next morning snow covered the ground to a depth of a quarter of an inch. Building was continued through the following day, and by then some forage piles had been half completed. At Driftwood, on August 29, 1952, piles were approximately three-fourths completed and only a few were less than one quart in volume. Singing voles can build forage piles in three days, and occasionally they do, when early in the autumn, low temperature and falling snow provide sustained incentive, but two to three weeks usually are devoted to the task. In 1952, forage piles in the mountains were finished earlier than those in the Plateau Province. Most of the forage piles are kept in place by being built around the basal stems of willow or dwarf birch. Some piles are built on and around horizontal or inclined branches of a shrub and are not in contact with the ground. A few piles are built in the open where they lack both support of stems and overhead protection. Some piles are placed under overhanging rocks that partly protect the piles from rain. Subterranean chambers usually are associated with those forage piles that are placed under such rocks whereas chambers are seldom associated with those forage piles that are built around the bases of shrubs. Some forage piles are placed directly on the unconsumed leaves of forage piles built in the previous year. The largest forage pile measured was 520 millimeters high and the volume was approximately eight gallons. The highest pile, 560 millimeters, was built around willow stems at Driftwood. At that place in 1952, in a quadrat of 800 square meters, there were 49 forage piles ranging in volume from one to 13 quarts. The largest of these piles was 450 millimeters in diameter at the base and 500 millimeters high. At this time (August 31) the volume of each pile exceeded a quart and the total volume of vegetation in these 44 forage piles was approximately one cubic meter. In some areas singing voles pruned and piled all of the foliage available in the immediate vicinity of the forage piles. Such pruning may hasten plant succession and conceivably influence fluctuations in numbers of voles. Where willow foliage was out of reach of the voles, they used understory plants. The trampling and defoliating of willows by caribou also caused the voles to utilize other kinds of vegetation. Willows that remain dwarfed—as many do owing to the influence of the climate—permit easy access to the leaves. The kind of vegetation used in building forage piles, depends to some extent on availability of the plants. Preference was evident, nevertheless, for in many instances where several kinds of plants were available only one kind was selected. Some piles, for example, were entirely of *Lupinus*. Other piles were a mixture of several kinds of plants. As a basal platform, *Equisetum* frequently was used and oftentimes to the exclusion of all other plants. In some forage piles there were layers of *Equisetum* alternating with layers of other kinds of plants; the *Equisetum* seemed to aid in aeration of the forage pile. One pile at Driftwood included by volume, *Aster sibericus,* one per cent; *Salix reticulatus,* one per cent; *Lupinus,* five per cent; *Petasites hyperboreus,* 10 per cent; *Astragalus umbellatus,* 10 per cent; *Equisetum,* 30 per cent; and small and large varieties of *Salix,* 42 per cent. A portion of this pile measuring 200 × 200 × 100 millimeters weighed 125 grams. At Chandler Lake, forage piles were principally of willow although many other herbaceous plants were available.

Preceding the period of building forage piles, accumulations of green leaves of willows frequently were placed at the edge of runways, but whether these accumulations were in some way related to the true forage piles, which are constructed later in the season, or were incidental to normal feeding, we did not ascertain. A system of runways generally converges on a forage pile and access to the top of the structure is gained by one or several approaches, depending on the shape of the pile. One forage pile per vole and individual ownership seem to be the usual situation; nevertheless an occasional individual vole has as many as 6 piles. Subadults on their own build forage piles but subadults and an adult sometimes join in work on a pile (see fig. 55).

The singing vole deposits fecal pellets in piles along runways; these piles disintegrate more rapidly than isolated pellets would, and add to the fertility of the soil.

The singing vole has a wider ecological distribution than any other microtine and therefore is associated with more kinds of mammals. Typically it lives in communities that are neither hydrosere nor xerosere. Because of its activity in exposed situations during both day and night, this vole is more exposed than any other microtine to various hazards, including predation by large carnivores.

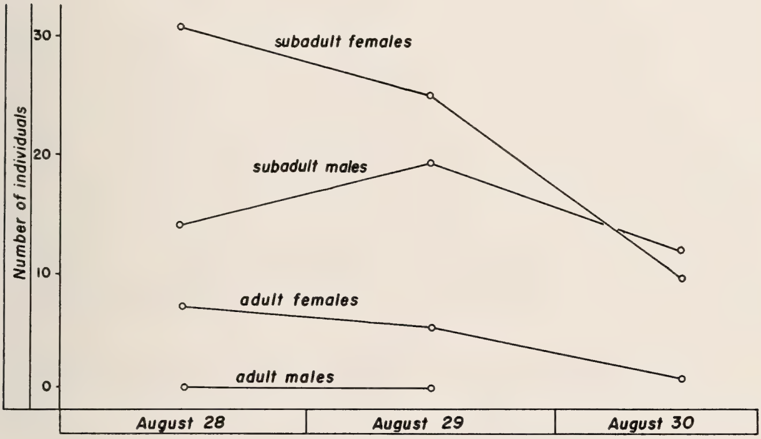


FIG. 55. Two age groups of *Microtus miurus muriei* caught on August 28-30, 1952, at Driftwood, Alaska, in snap traps placed at forage piles for 65 consecutive hours. The traps were set at 5 p.m., were subsequently inspected, rebaited and reset if sprung, morning and night until taken up at 10 a.m. In this period the females were more active in building forage piles than were the males.

In the mountains, the singing vole is associated with the red-backed vole at the contacts of their communities. A line of traps, set for six consecutive days on and along two such communities, revealed that only a small area was shared; only six per cent of 63 traps caught both species. The singing voles were the first to be trapped out, indicating that they wander less and are more nearly confined to trails than are the red-backed voles. A high percentage of traps caught only one singing vole; perhaps each had its own territory.

Along the borders of swales and where canyon sides meet low wet meadows the singing vole invades the community inhabited by the tundra vole but the tundra vole seldom enters the dry communities inhabited by the singing vole. The two species meet also along eroded banks on the shores of lakes where the tundra vole occupies wet grasses at the base of the bank and the singing vole the higher slopes and flat area at the top of the bank. In many of their normal activities the two species are separated by only two meters or less. Where the height of the bank is less than a third of a meter, the singing vole is excluded and the tundra vole inhabits the shore line. Runways of the Arctic ground squirrel and singing vole frequently cross one another. Some forage piles of the vole were built as near as three meters to the mouth of a ground squirrel burrow. Abandoned burrows of ground squirrels are used by singing voles. Caribou greatly influence, although usually only locally, the community inhabited by the singing vole. In meadows, deep trails made by caribou, depending on direction of drainage, can produce wet or dry meadows; singing voles inhabit those of optimum moisture conditions and, at the edges of steep swales, also areas denuded by caribou. Defoliation of the willows in the migratory lanes of caribou handicaps the singing vole but it is more proficient than any other mocrotine in surviving and in reorganizing its burrows after such devastation.

The grizzly bear, wolf, wolverine and probably red fox and two kinds of weasels feed on the singing vole. The larger carnivores turn over the shallow soils in areas of as much as two square meters where the singing vole has its burrows; if the voles are not captured they reëstablish themselves by digging new chambers and by connecting new runways with such peripheral runways as were not destroyed by the digging of the carnivores.

When an intruder invades the territory of the singing vole it sometimes utters a defense call, especially when forage piles are being built. The call is a continuous chirping note without modulation and is clearly audible to the human ear at three meters distance.

Subterranean chambers and corridors provide shelter. These shelters and also storage chambers are made by voles in autumn in the period when the forage piles are being built. Singing voles create bare areas of up to half of a square meter by depositing excavated soil on top of the ground. Soil that is removed from the deep holes is in the form of small granular pellets, which are carried to the surface in the mouth of the vole. The sheer effect of voles' trails on the sides of a canyon at some times and places excludes vegetation, especially around entrances of burrows.

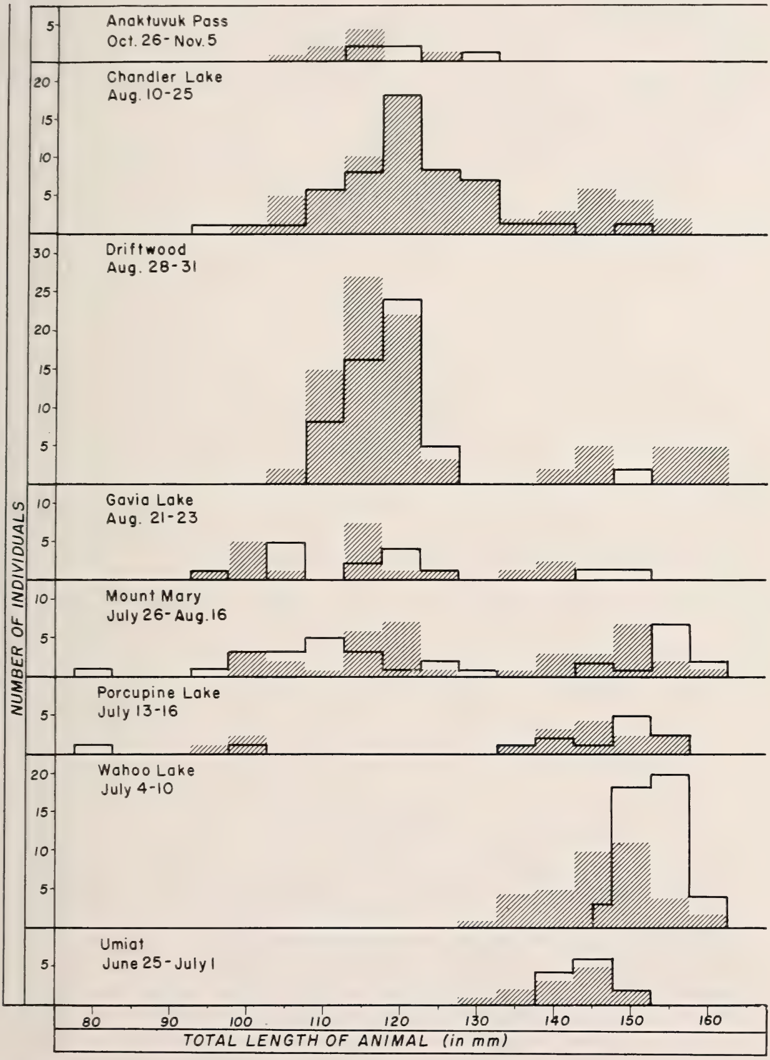


FIG. 56. Percentages of males and females in the two age groups (adults and subadults) of *Microtus miurus muriei*, from eight localities on the Arctic Slope of Alaska. The males are represented by areas surrounded by heavy borders and females by shaded areas.

In autumn, voles are in family groups. One trap at the entrance of a burrow caught one adult female and six subadults. An adult female lived in an area of 20 by 1 meters; the area was isolated from other singing voles by at least 200 meters. The singing vole extends its immediate range by exploration and invasion either by wandering or by chance. If the new situation fills all requirements, a new population will be established but if the situation is marginal it will be abandoned. Rains in autumn cause voles to leave marginal communities used in summer.

The original invasion into the glaciated valley of the Brooks Range probably was from higher elevations above the glaciated canyons rather than from lowlands to the north or south whence the tundra vole and brown lemming probably came. Extension of the range from the mountains onto the Plateau Province to the north

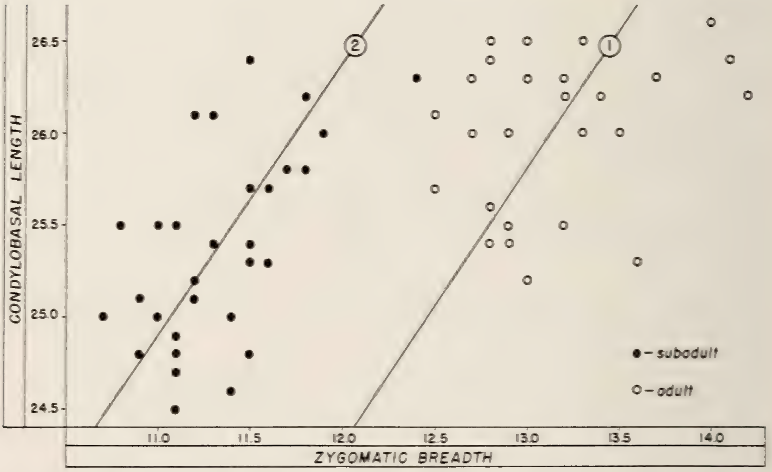


FIG. 57. Regression lines of measurements (condylobasal length and zygomatic breadth) of skulls of (1) breeding adults of both sexes of *Microtus miurus muriei* trapped in early spring and (2) corresponding data for pre-adults trapped in autumn, from the Arctic Slope of northern Alaska, showing differences in size of animals born in winter and those born in summer. Both sexes are included. The breeding adults were trapped between June 25 and July 13, 1952, from Umiat, Porcupine Lake, Mount Mary and Wahoo Lake and the subadults, including post-juveniles and pre-adults, were trapped between August 15 and September 3, 1951 and 1952, from Chandler Lake, Umiat and Driftwood. Individuals born in winter never "catch up," in condylobasal length, to animals born in the succeeding spring, after the latter are two and a half months old. Measurements are in millimeters.

was perhaps along the sides of the steep channels of the rivers or along other avenues of relief.

In summer there are two age groups: (1) breeding adults (presumably born in the preceding summer) and (2) individuals born since the preceding winter. The average size of these breeding adults increases five per cent between spring and autumn (see fig. 56).

In fourteen breeding adults trapped in early spring between June 25 and July 13 from Umiat, Wahoo Lake and Porcupine Lake, the condylobasal length is 25.0 to 27.0 millimeters. These adults were compared with 14 subadults, trapped in the autumn between August 13 and September 3, at Umiat, Chandler Lake and Driftwood in which the condylobasal lengths were the same as in the adults. Some of the more significant differences in larger size (in per cent) of the subadult specimens are as follows: Total length, 10.6; tail,

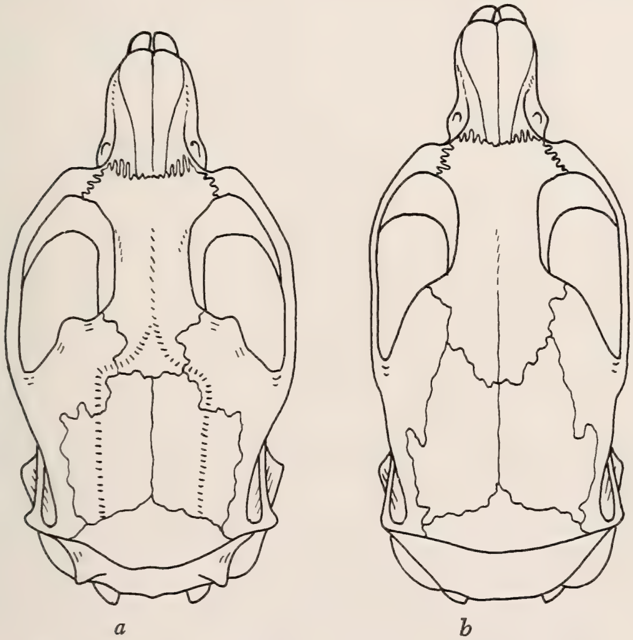


Fig. 58. Dorsal views of two skulls of *Microtus miurus muriei* to show greater length and potentially greater size of the individual (*b*) born in spring in comparison with the older individual (*a*) born in winter. × 3.
a. Adult, ♀, No. 51058 KU, 4/10 mi. W and 9/10 mi. N Umiat, 152°10′58″, 69°22′53″, 380 ft., July 1, 1952.
b. Subadult, ♀, No. 43741 KU, 1½ mi. W and ¾ mi. N Umiat, 152°08′ 10″, 69°22′18″, 370 ft., August 31, 1951.

7.2; nasals, 6.0; zygomatic breadth, 11.6; basal width of rostrum, 8.2; palatofrontal depth, 8.6; width across braincase between medial edges of the supratympanic fenestrae, 3.5; weight, 40.0. Most parts of the skulls and bodies of the breeding adults, which received the impact of the winter environment in the formative period of growth, are smaller than the corresponding parts of skulls and bodies of the subadults trapped in autumn. Availability of green vegetation for food, higher vitamin content of food, more light, and more equitable climatic conditions may have caused more rapid growth during summer in the subadult group. The existence of seasonal variation in the size of an animal suggests that the formation of species and subspecies could be brought about in the same area by a change in the relative length of the winter and summer.

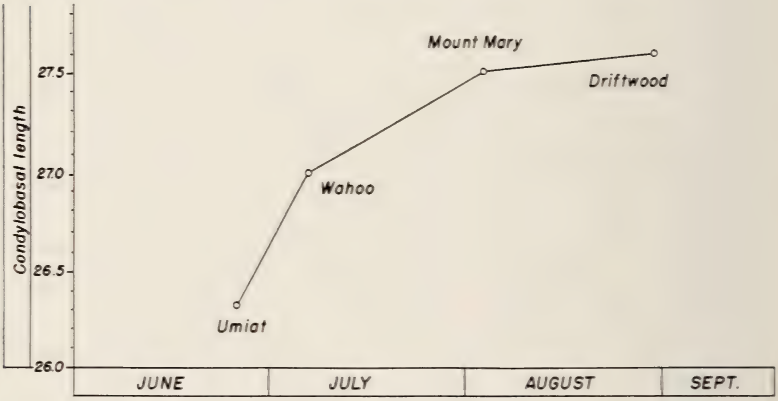


FIG. 59. Showing a seasonal trend in the average size of adults of *Microtus m. muriei* from the Arctic Slope of northern Alaska in 1952; in the latter part of August, adults average 5 per cent larger in linear dimensions of the skull and body than in the latter part of June. The number of adults (males and females combined) averaged from each of the four localities are as follows: Umiat, 22; Wahoo, 60; Mount Mary, 28; Driftwood, 19.

Reproduction

In the later part of June and early July, testes already had reached their maximum size; the average length of testes of adult breeding males, taken between June 25 and August 3, at Umiat, Wahoo Lake, Porcupine Lake and Mount Mary was 11 (6-13) millimeters. Between August 10 and September 3 at Chandler Lake, Driftwood and Umiat the size of the testes in breeding adults was less, averaging 6.6 (5-9). The smaller testes of the breeding adults of spring were in old males (one animal measured 160 millimeters in length). In 136 subadults from various localities on the Arctic Slope with total lengths of between 95 millimeters and 135 millimeters, the length of the testes was 2.8 (2-4) millimeters; none seemed to be in breeding condition.

The average number of embryos per female at the time of greatest reproductive activity was 8.2 There is no significant difference in the number of embryos in either the left (4.13) or the right (4.10) side of the uterus. Extremes in numbers of embryos were: 5 × 0, 8 × 2, 6 × 6, and 2 × 2. A set of 4 × 4 embryos was made up of five that were 15 millimeters long and three that were only four millimeters long. The small embryos were not being absorbed as is usually the case in instances in which there are embryos of different sizes in the same uterus. The largest embryo in 46 pregnant females was 23 millimeters in crown to rump measurement.

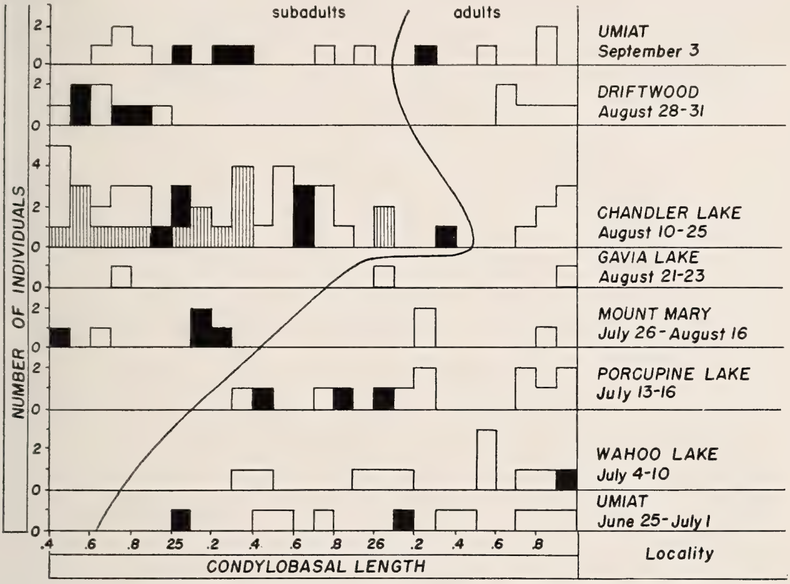


FIG. 60. Distribution graph (in part) of two age groups of *Microtus miurus muriei,* trapped from June 25 to September 3, 1951 and 1952, from eight localities on the Arctic Slope. Animals having a condylobasal length of less than 24.4 and those with a condylobasal length of more than 26.9 are not shown on the graph. Localities are arranged according to date from spring to autumn. The voles that are born in spring have the advantage of increased solar illumination, green foods and high temperatures are considerably larger than voles that are born in winter when the solar illumination is decreasing, when the food is not green and when the temperatures are low. Symbols: males = white; females = black; males and females = shaded.

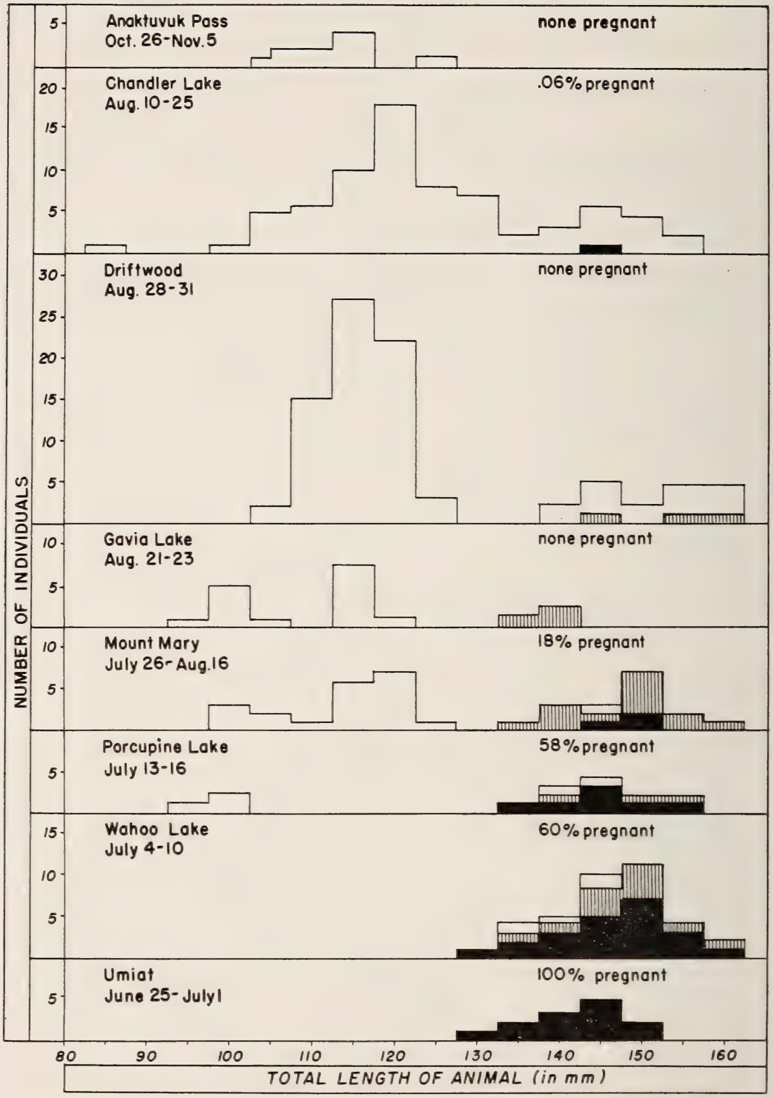


FIG. 61. Showing age groups of, and reproductive condition of, 289 females of *Microtus miurus muriei* trapped from June 25 to November 5, 1951 and 1952, from eight widely separated localities on the Arctic Slope of northern Alaska. The black areas, representing pregnant females, and the shaded areas representing females with placental scars, are superimposed on an area outlined to represent all females, "pregnant or otherwise."

The smallest female bearing embryos was 131 millimeters in total length and the largest female was 162 millimeters. The average size was 147 millimeters. The largest number of embryos (12) was in a female that measured 132 millimeters in total length and the smallest number of embryos (4) was in a female that measured 142 millimeters. The total length of the females bearing the least number of embryos is approximately 144 millimeters. The latest date on which embryos were found was August 11, 1951; this was at Chandler Lake, and embryos in the female concerned measured 22 millimeters in crown to rump length. Placental scars, however, were found as late as September 3 at Umiat. In a series of specimens collected on November 5 in Anaktuvuk Pass there was a subadult approximately three weeks old (condylobasal length 22.7 mm) showing that young were conceived there in late September. These late seasonal records of embryos and small subadults indicate that some individuals reproduce between late summer and early spring. Elevation and exposure cause minor differences in the time of breeding.

One parietal bone of skull number 51182 has a small hole presumably made by a parasite.

In 12 linear measurements of the skulls of 67 adult breeding males and 67 adult breeding females of the same age as the males from several localities on the Arctic Slope of the Brooks Range, females average 3.4 per cent smaller than males. Of the several measurements the palatofrontal depth differs most, 7.2 per cent, and the zygomatic breadth is 5.8 per cent smaller in females. The rostrum also is narrower in females. The measurement that differs least between the two sexes is the interorbital breadth, which is almost as much in females as in males. Width across the braincase between the medial edges of the supratympanic fenestrae in females is 1.5 per cent smaller than in males. This measurement expresses actual difference in size. In the subadult age group, females average only about two per cent smaller in linear measurements than males.

Judging by animals trapped, the sex ratio among breeding adults is approximately 50–50 in spring but by late summer there are more females (see fig. 56). The seeming decrease in number of adult males in summer and autumn probably is caused by greater exposure of males to predation, fighting among themselves and other ecological pressures. The sex ratio of the subadults remains at approximately 50–50 throughout the summer.

Pelage

The pelage of the singing vole is made up of three types of hair as follows:

Guard hair.—Distal ¼ black; remainder consisting of alternating zones of black and white; longest hair; terminal part rigid; present on only back and upper parts of sides as in the brown lemming.

Cover hair.—Differs from guard hair as follows: shorter; less rigid; covers entire body; more elliptical in cross-section and bends more readily at base of colored part; tends to lie flat instead of sticking straight up. In colored part of pale pelage of spring less brown pigment than in dark pelage of late summer; cover hairs in winter paler than in summer or spring and pigmented and un-

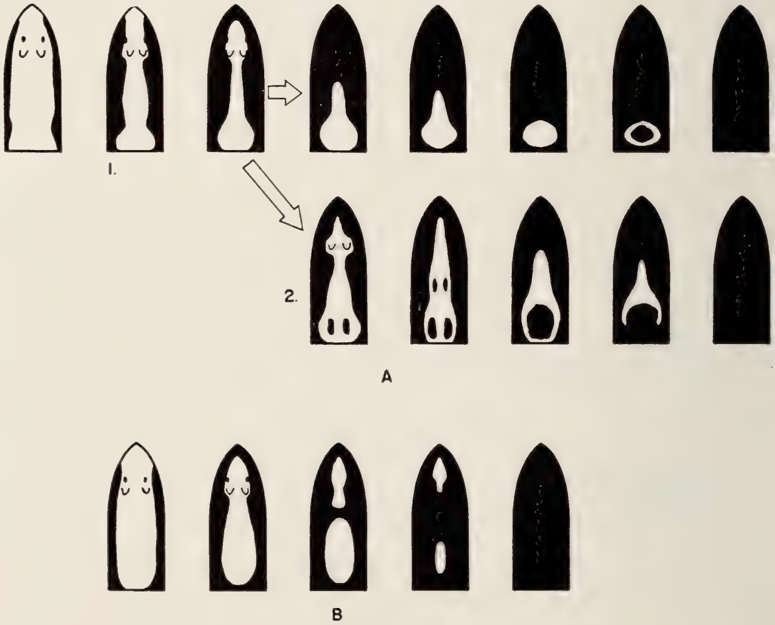


Fig. 62. Pigmentation of the skin (hair side), indicative of growth of hair, in breeding-adult pelage and late summer-adult pelage (dorsal aspect only). Specimens from several localities in the Brooks Range and on the Plateau Province, trapped from June to September, of 1951 and 1952, were used to ascertain sequence of pelage. (Read from left to right.)
A. Normal sequence of the growth of new hair of breeding pelage.
  1. Growth of hair on rump is interrupted by sebaceous glands on flanks. Hair on rump usually grows from a growth-center there.
  2. Variation of sequence of growth of new hair on rump.
B. Sequence of growth of new hair of the late summer pelage in adults.

pigmented parts both longer; white hair occasional, especially where two converging growth lines meet. Hair in area of sebaceous gland long and rigid, and may be modified cover hair. These hairs and those posterior to the gland frequently are covered with an oily secretion.

Underfur.—Shorter than cover hair.

Sequence of Pelages

An individual singing vole that is born in spring has four different pelages by early winter. These pelages are juvenal, post-juvenal, pre-adult and winter-adult. If the vole lives into the second winter there are four more pelages, namely breeding-adult, post-breeding adult, late summer-adult and winter adult.

Juvenal Pelage. The early juvenal pelage resembles that in the brown lemming in that the pigmentation and hair begins to grow on top of the head and back; the growth line moves ventrally. Juveniles born in winter have longer hair than those born in summer.

Post-juvenal Pelage. This pelage grows into, through and beyond the juvenal pelage. The growth-centers are low on the sides of the body; from these centers the line of growth of new hair moves

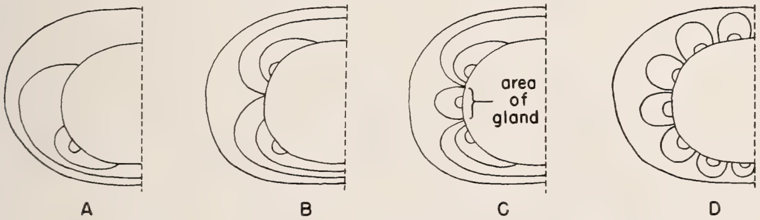


Fig. 63. Variations in growth of new hair in the change of pelage of *Microtus miurus muriei* from the Brooks Range and Plateau Province. Cross-sections of the left side of the body are shown (¾ natural size).
A. Change of pelage in post-juveniles and pre-adults. Growth centers are low on the sides of the body from which position new hair grows dorsally and ventrally and converges on the ventral and dorsal midlines.
B. Change of pelage in adults. In addition to the regular growth-center (see *A* above) there is one high on the side. The two centers grow either simultaneously or in sequence.
C. Showing the influence of the sebaceous gland on the growth of hair. In subadults the growth of hair may pass uninterruptedly through the area of the gland or, as a variation, hair from upper and lower growth-centers may converge at the gland. In all older animals, the gland has its own growth-center.
D. Showing irregular change of hair and molt in older animals, especially in those having excessively worn pelage.

dorsally and ventrally. Pigmentation develops over the entire body at approximately the same time instead of in only certain areas as when the pre-adult pelage is acquired. In some specimens, the top of the head between the ears and the nose is the area last to grow post-juvenal hair. One specimen (51115) from Mount Mary at the south end of Lake Peters has a remnant of post-juvenal pigmentation and an area of actively growing pre-adult pelage low on each side. The occurrence simultaneously of two pelages on the same animal would indicate that the time interval between the

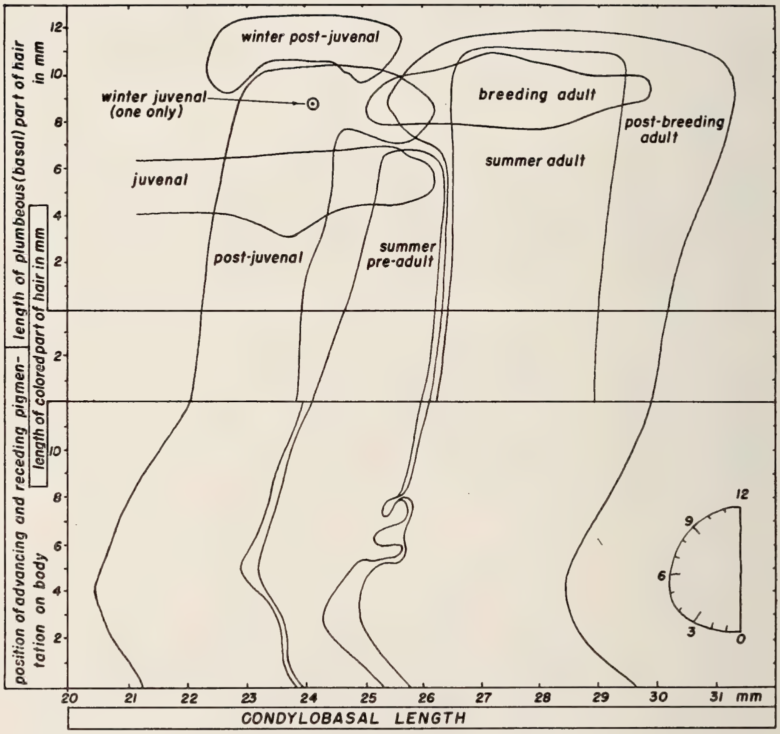


Fig. 64. Condition of pelage of *Microtus m. muriei* from the Arctic Slope of northern Alaska from June 25 to September 3 of 1951 and 1952. The five specimens in winter pelage were captured from October 26 to November 5. The perpendicular scale consists of three separate units: the lower unit shows equal divisions (1-12) of one side of the animal from the ventral midline to the dorsal midline (see insert at right); the middle unit shows the length of the colored (distal) part of the hair from the middle of the back (position 12 insert at right); and the upper unit shows the length of the plumbeous (basal) part of the same hair. The three units, in the aggregate, express progressive advance of hair growth and advance and regression of the pigmentation of the skin which precede hair growth.

early pelages is short. Short-haired juveniles tend to acquire relatively longer post-juvenal hair and conversely long-haired juveniles tend to acquire shorter post-juvenal hair than the average. The hair in post-juveniles of winter is longer than in post-juveniles of summer.

Pre-adult Pelage. The incoming pre-adult pelage is the most regular, with respect to pattern of growth, of all the changes of pelage. The growth-center of developing hair is in the same position as in the post-juveniles. The line of newly growing hair moves progressively to the dorsal and ventral midlines of the body, at any one time being confined to that narrow zone on the skin where the pigment is being developed and the new hair is growing. The sebaceous gland is not active during the early pre-adult stage and although somewhat enlarged in the late stages of the pre-adult animal, is not functional until the adult stage is reached.

Breeding-adult, Post-breeding adult, Late Summer-adult and Winter-adult pelages. Each of these pelages grows from several centers; hair begins to grow in all of the centers at the same time. The winter pelage is long and pale. Specimens taken on September 3, were still in late summer pelage and those on October 26 were in winter pelage. The new pelage is acquired last on the rump, seemingly because the progress of the line of hair growth is retarded by the flank glands. Characteristically there is a separate growth-center of hair on the rump. In some animals new hair fails to grow on the rump. In that event the hair of the preceding pelage is retained. Several specimens trapped in the latter part of June, 1952, at Umiat, were in breeding pelage, but still had on the rump only the intact winter pelage. In the pelage of late autumn there is a tendency for the line of growth of hair to converge on the head and to move to the rear. There are also several autumn-taken specimens having new pelage on the back (area covered by guard hairs) completed but lacking even a trace of new pelage on the venter. The pelage of late summer, on the average, is considerably darker brown than the breeding pelage or post-breeding pelage.

Records of occurrence.—Specimens examined, 377: Nos. 43020-43037, 43729-43803, 43805-43846, 51039-51280 (Nos. 43022-43024, 43026, 43027, 43030-43033, 43035-43037, 51103, 51181, 51185, 51207, 51208, 51212, 51228, 51242-51249 are skulls only and Nos. 43801, 43823, 51182-51184, 51187, 51188, 51206, 51221, and 51224 are skeletons. No. 43021 is a skin only). These are distributed by localities as follows: (2) Gavia Lake, 150°00′, 69°35′, 460 ft., N White Hills, Brooks Range, 12; (3) $1\frac{3}{10}$ mi. E and $1\frac{3}{10}$ mi. N Umiat, 152°05′30″, 69°23′12″, 350 ft., 4; (4) $\frac{9}{10}$ mi. W and $\frac{9}{10}$ mi.

N Umiat, 152°10′58″, 69°22′53″, 380 ft., 16; (5) 1½ mi. W and ¾ mi. N Umiat, 152°08′10″, 69°22′18″, 370 ft., 18; (6) Umiat, 152°09′30″, 69° 22′08″, 352 ft., 4 (see also Rausch, 1950b:135; 1951:183; 1953:135); (7) Spawning Creek, W side Lake Schrader, 145°11′40″, 69°25′08″, 2908 ft., Brooks Range, 2; (8) Lake Schrader, 145°09′50″, 69°24′28″, 2900 ft., Brooks Range, 5 (see also Rausch, 1951:183, 1953:135); (9) E side Lake Schrader-Lake Peters Channel, 145°09′30″, 69°24′15″, 2905 ft., Brooks Range, 1; (10) Mount Mary, S end Lake Peters, 145°10′05″, 69°20′35″, 3012 ft., Brooks Range, 39; (11) Mount Mary, S end Lake Peters, 145°10′02″, 69°20′30″, 2920 ft., Brooks Range, 17; (12) Wahoo Lake, 146°58′, 69°08′, 2350 ft., Brooks Range, 62; (13) Driftwood, Utukok River, 161°12′10″, 68°53′47″, 1200 ft., 52 (see also Rausch, 1953:134 [head of Utukok River]); (14) Porcupine Lake, 146°29′50″, 68°51′57″, 3140 ft., Brooks Range, 28; (16) Chandler Lake, 152°45′, 68°12′, 2900 ft., 99; (17) Anaktuvuk Pass, 18 (see also Rausch, 1951:184, 1953:134).

Additional records: (1) Fish Creek, SE of Teshekpuk Lake (Rausch, 1953: 135); (15) Tolugak [Tulugak] Lake (lat. 68°24′ N, long. 152°10′ W), Brooks Range (Rausch, 1950b:135; 1950c:466).

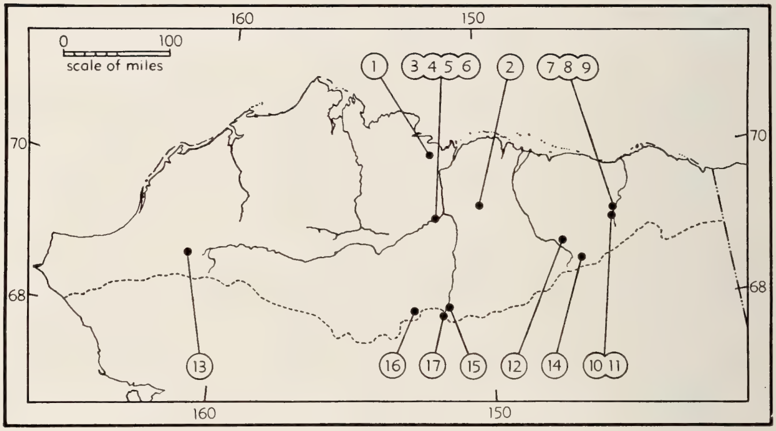


FIG. 65. Record stations of occurrence for *Microtus miurus muriei.*

Erethizon dorsatum myops Merriam

Porcupine (Kingagluk)

Erethizon epixanthus myops Merriam, Proc. Washington Acad. Sci., 2:27, March 14, 1900, type from Portage Bay, Alaska Peninsula, Alaska.

Erethizon epixanthum, Anderson, Report on the Natural History Collections of the Expedition (1908-1912) in "My life with the Eskimo" by V. Stefansson. New York: The Macmillan Company, p. 514, 1913.

Erethizon epixanthum epixanthum, Anderson, Mammals and birds of the western Arctic District, Northwest Territories, Canada *in* Canada's Western Northland, p. 114, July 9, 1937.

Erethizon dorsatum myops, Rausch, Jour. Mamm., 31:466, November 21, 1950. (Also Rausch, 1951:185.)

Description.—Large (2½ feet long), black or yellowish-black rodent having barbed quills on upper parts; tail approximately 8 inches long and thick; muzzle blunt; eyes and ears small; feet plantigrade with strong, sharp claws;

front foot four-toed, hind foot five-toed; skull having large infraorbital canal; teeth 20, brachydont, rooted.

Total length, 749; tail, 204; hind foot, 89 (Dixon, 1938:189, material from Mount McKinley); condylobasal length of skull, 104 (an adult male from the Chitna River that measured 800 mm in total length—Anderson and Rand, 1943:303).

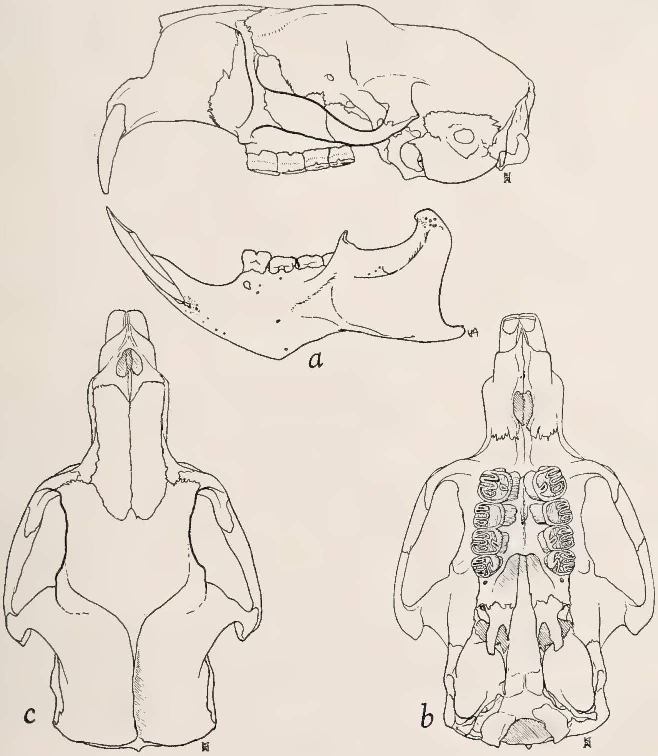


Fig. 66. Skull of *Erethizon dorsatum* [subspecies *epixanthum* Brandt], Wilson Creek, 7200 ft., Nye Co., Nevada, No. 88223 MVZ, ♂. × ½.

Remarks.—The name *Erethizon d. myops* is provisionally used until specimens from the Arctic Slope become available.

On July 12, 1952, approximately four miles west of Porcupine Lake, William Brosge of the United States Geological Survey saw a porcupine crossing the boulders and sands of the dry bed of the Ivashak River between two islands of shrublike trees. Here there were dense and extensive stands of willow and alder along the edges of the braided river and on the islands in it. The shrublike trees were so thick as to be almost impenetrable for man.

Tracks of a red fox were on the sands of the river bed near the porcupine. In the canyon west of Porcupine Lake, the bark of willows had been eaten by what we presumed to have been a porucpine.

The porcupine probably is relatively common in the Brooks Range and to a lesser degree on the Plateau Province, especially along major streams wherever there are willow, alder and other treelike shrubs.

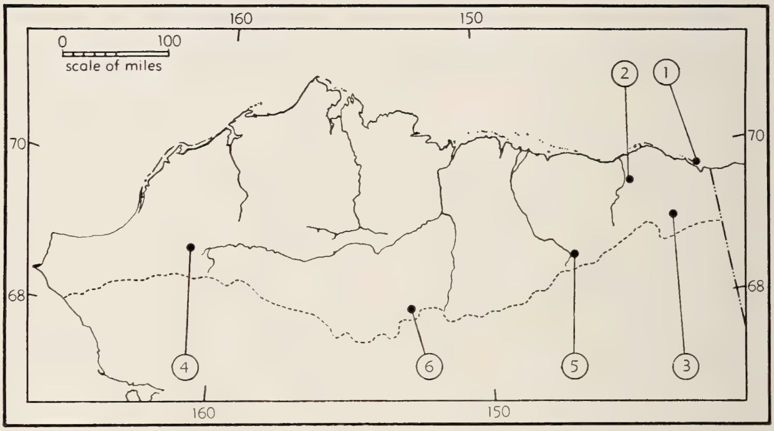


Fig. 67. Record stations of occurrence for *Erethizon dorsatum myops.*

Records of occurrence.—Specimens examined, none.

Records: (1) Icy Reef (Anderson, 1913b:514; 1937:114); (2) Hulahula River (Anderson, 1913b:514; 1937:114); (3) Endicott Mountains [Brooks Range], west of Alaskan boundary [definite locality unspecified] (Anderson, 1937:114); (4) 5 mi. NE Driftwood, 161°11′00″, 68°56′30″ (three-fourths grown, seen by Charles W. Whittington on September 5, 1950); (5) Ivashak River, 146° 39′15″, 68°51′12″ (seen by William P. Brosge—*fide* J. W. Bee, MS, 12 July 1952); (6) Chandler Lake (Rausch, 1950c:466; 1951:185).

Delphinapterus leucas (Pallas)
White Whale (Sisuak)

Delphinus leucas Pallas . . . . Reise durch verschiedene Provinzen des russischen Reichs 3 (book 1):85, footnote, 1776, type from mouth of Obi River, northeastern Siberia, U.S.S.R.

D[*elphinapterus*]. *leucas,* G. Cuvier, Ann. Mus. Hist. Nat. Paris, 19:13, 1812.

Delphinapterus leucas, True, Bull. U.S. Nat. Mus., No. 36, p. 187, 1889. (Also W. Stone, 1900:34; Elliot, 1901:19; MacFarlane, 1908:232; Stone and Cram, 1905:24; Anderson, 1937:101; Dufresne, 1946:194; Anderson, 1947:86.)

Delphinapterus catodon, True, Proc. U.S. Nat. Mus., 7 (App., Cir. 29): 590, November 29, 1884. (Also Dall *in* Scammon, 1874:283; Nelson and True *in* Nelson, 1887:233-288; Anderson *in* Stefansson, 1913b:500.)

Beluga sp., Murdock *in* Expedition to Point Barrow, Alaska, 48th Congress, 2nd Session, Ex. Doc. No. 44 by P. H. Ray, p. 99, 1885.

Delphinapterus leucus, Bailey and Hendee, Jour. Mamm., 7:27, February 15, 1926.

Range.—Arctic Ocean.

Description.—Relatively small, length 11-14 feet, no dorsal fin, color everywhere white. See fig. 69 on page 160.

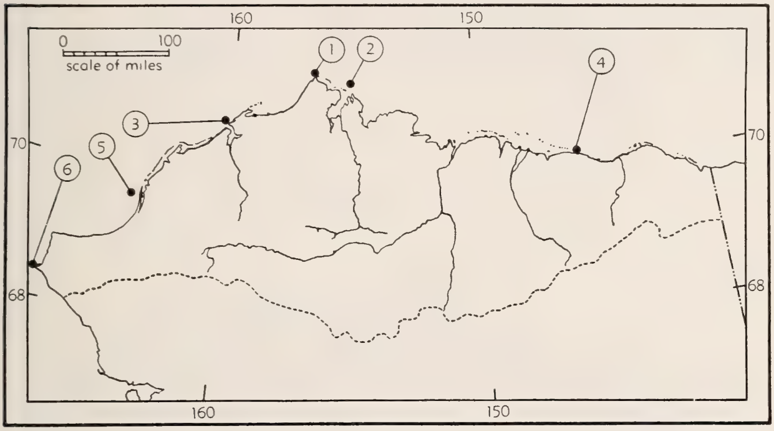


FIG. 68. Record stations of occurrence for *Delphinapterus leucas.*

Records of occurrence.—Specimens examined, none.

Records: (1) Point Barrow (Murdock *in* Ray, 1885:99; Nelson and True *in* Nelson, 1887:290; W. Stone, 1900:34; Bailey and Hendee, 1926:27; Anderson, 1937:101; seen by Pete Sovalik in 1950—*fide* J. W. Bee, MS, 8 September 1952); (2) Arctic seas [definite locality unspecified] (Dall *in* Scammon, 1874: 283; True, 1889:188; Elliot, 1901:20; Trouessart, 1904:772; MacFarlane, 1908: 232; Stone and Cram, 1905:24; Anthony, 1928:571; Anderson, 1937:101; Anderson, 1947:86); various points along the Arctic Coast (Anderson *in* Stefansson, 1913b:500); Arctic Coast off Point Barrow (Nelson and True *in* Nelson, 1887:233); Polar Cape south to about lat. 56 (Dufresne, 1946:194); (3) Wainwright (Bailey and Hendee, 1926:27; two seen by Pete Sovalik in spring of 1952—*fide* J. W. Bee, MS, 8 September 1952); (4) Flaxman Island (Leffingwell, 1919:63); (5) [between Cape Beaufort and Icy Cape] (Beechey, 1831:372 "small white whales"); (6) Point Hope (Nelson and True *in* Nelson, 1887:289; Bailey and Hendee, 1926:27; Rainey, 1940:362).

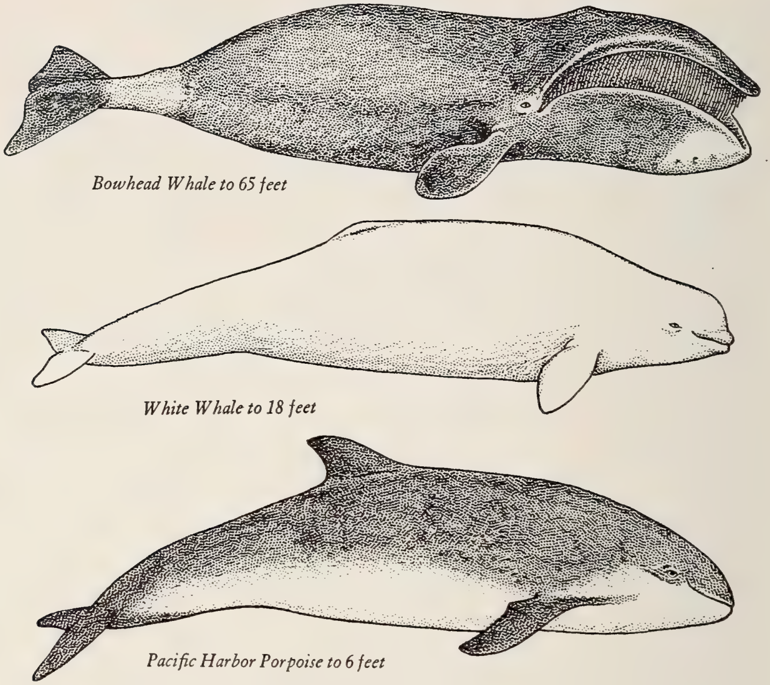
Monodon monoceros Linnaeus

Narwhal (Sisuak tugalik)

[*Monodon*] *monoceros* Linnaeus, Systema Naturae, ed. 10, 1:75, 1758, type from Arctic seas.

Monodon monoceros, Dall, *in* The marine mammals of northwestern coast of North America by Scammon, New York, p. 283, 1874. (Also True, 1884: 590; Murdock *in* Ray, 1885:100; Nelson and True *in* Nelson, 1887:233, 290; True, 1889:188; Elliot, 1901:19; MacFarlane, 1908:236; Stone and Cram, 1905:24; Miller, 1924:514; Anderson, 1937:101; Dufresne, 1946: 195; Anderson, 1947:87.)

Range.—Arctic Ocean.



Bowhead Whale to 65 feet

White Whale to 18 feet

Pacific Harbor Porpoise to 6 feet

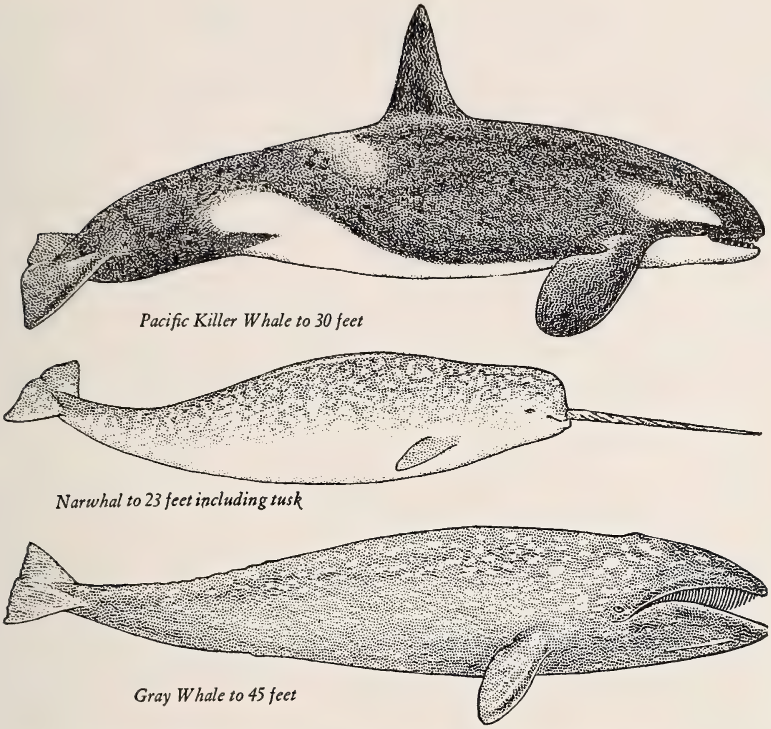
FIG. 69. SIX CETACEANS IN LATERAL ASPECT; NOTE DIFFERENCE IN

Description.—Length 12 feet, males with one canine tooth twisted anteriorly as long as 9 feet, females usually not showing tusks externally; upper parts mottled dark gray, below white (see fig. 69).

Pete Savolik saw a narwhal, which had been dead for a long time, on the beach NW of Atigaru Point in September, 1929. He considers the narwhal a rare mammal along the Arctic Coast. Clay Kaigelak, now (1952) living at Barrow Village but formerly residing at Beechey Point and Foggy Island, had never seen a narwhal.

Records of occurrence.—Specimens examined, none.

Records: (1) Point Barrow (Murdock *in* Ray, 1885:100, occasionally seen by natives at Point Barrow); Point Barrow east to [international boundary] (Nelson and True *in* Nelson, 1887:233,290); Point Barrow region (Anderson, 1937:101); Point Barrow (Anderson, 1947:87); (2) [definite localities unspecified] Arctic seas (Dall *in* Scammon, 1874:283; Elliot, 1884:590; True, 1889:188; Elliot, 1901:19; Stone and Cram, 1905:25; Anthony, 1928:572; Miller, 1924:514; Anderson, 1947:87); Arctic Ocean (Trouessart, 1904-05: 772); Alaska and ... seas of Arctic America (MacFarlane, 1908:236); Arctic Coast from Demarcation Point to Point Barrow (Dufresne, 1946:195); (3) 12 mi. W and 3 mi. N Atigaru Point, 152°47′, 70°37′ (seen by Pete Sovalik on September 1, 1929—*fide* J. W. Bee, MS, 8 September 1952); (4) mouth of Colville River (seen by Charles D. Brower and reported by his son Thomas Brower—*fide* J. W. Bee, MS, 11 September 1952).



Pacific Killer Whale to 30 feet

Narwhal to 23 feet including tusk

Gray Whale to 45 feet

COLOR-PATTERN, MOUTH, AND PRESENCE OR ABSENCE OF DORSAL FIN.

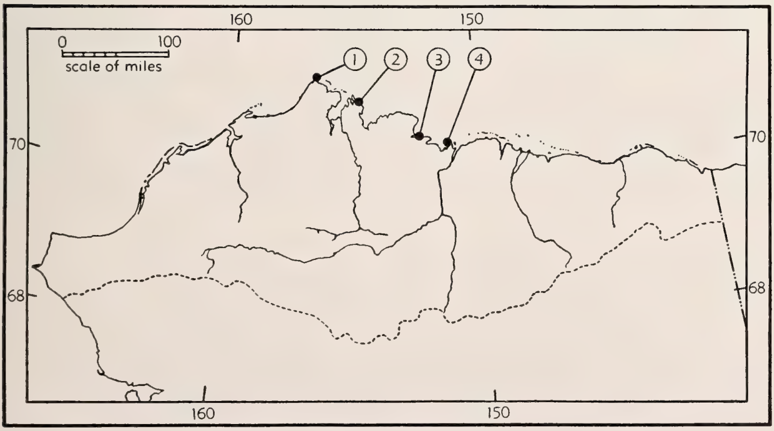

160
150
0
100
scale of miles
1
2
3
4
70
70
68
68
160
150

FIG. 70. Record stations of occurrence for *Monodon monoceros.*

Grampus rectipinna (Cope)

Pacific Killer Whale (Aglu)

Orca rectipinna Cope, Proc. Acad. Nat. Sci. Philadelphia, 21:22, 1869, type from coast of California.

Orca sp., Murdock *in* Expedition to Point Barrow by P. H. Ray, 48th Congress, 2nd Session, Ex. Doc. No. 44, p. 100, 1885. (Also Nelson and True *in* Nelson, 1887:290.)

Orcinus rectipinna, Bailey and Hendee, Jour. Mamm., 7:27, February 15, 1926. (Also Dufresne, 1946:192.)

Range.—Arctic Ocean.

Description.—Length of male, 20-30 feet; nose blunt; dorsal fin high and nearly straight; upper parts black; underparts and sides with white patches but may be black without markings; see fig. 69 on page 161; skull with teeth large, conical, 12 above, 13 below; rostral part of skull elongate.

Pete Sovalik told us that the killer whale is still occasionally taken at Barrow Village by the Eskimos. He has seen these whales take small seals which were resting upon the edge of the ice.

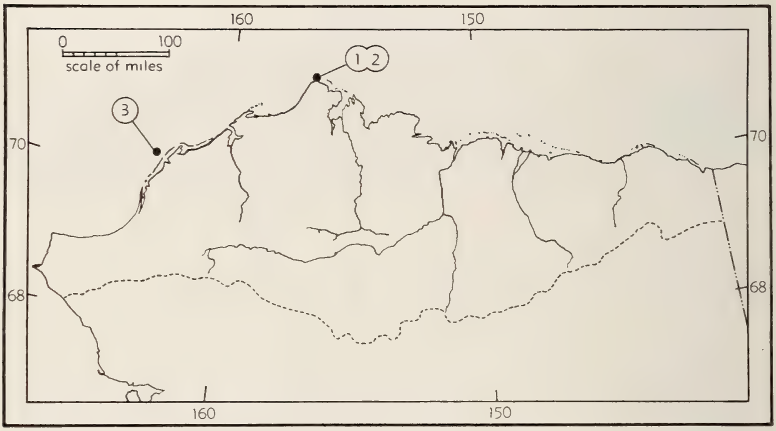


FIG. 71. Record stations of occurrence for *Grampus rectipinna.*

Records of occurrence.—Specimens examined, none.

Records: (1) [Point Barrow] (Murdock *in* Ray, 1885:100, seen by Eskimos; Dufresne, 1946:192; reported by Eskimos at Barrow Village—*fide* J. W. Bee, MS, 8 September 1952); (2) Barrow (Bailey and Hendee, 1926: 28); (3) [from Cape Thompson] to Point Barrow (Nelson and True *in* Nelson, 1887: 291).

Phocoena vomerina Gill

Pacific Harbor Porpoise (Agvisuak)

Phocoena vomerina Gill, Proc. Acad. Nat. Sci. Philadelphia, 17:178, 1865, type from Puget Sound, Washington. (Also Hall and Bee, 1954:124.)

Range.—Lagoons and Arctic Ocean northeast at least as far as Elson Lagoon.

Description.—Length less than 6 feet; slaty black, paler below; see fig. 69 on page 160. A female (U.S.N.M. No. 294800) caught by David Otoana in a gill net on August 6, 1952, in the northwest part of Elson Lagoon, 156°35′45″, 71°20′27″, was measured by Norman J. Wilimovsky. Snout to base of tail notch, 1620; girth behind flippers, 812; girth at origin of tail flukes, 198; girth at origin of dorsal fin, 833; maximum width across tail-flukes, 330; snout to origin of dorsal fin, 720; eye opening, 11 × 21; length of flipper, 230; weight, 109 lbs. A young porpoise (U.S.N.M. No. 294801), obtained on August 23, 1952, by the son of Clay Kaigelak in the same lagoon (see specimens examined), measured: Over-all length, 910; length along curve of back from tip of snout to base of notch between tail-flipper, 924; circumference immediately behind flippers, 470; maximum circumference of caudal peduncle immediately in front of hind flipper, 122; circumference of body immediately behind dorsal fin, 405; width across tail flukes, 203; distance from tip of snout to anterior base of dorsal fin, 415; length of flipper on front edge, 171; weight, 22½ lbs. Whalelike; dorsal fin triangular; teeth small, spade-shaped, slightly flattened, approximately 25 above, 24 below; upper parts slaty-black or brownish, underparts paler; line from corner of mouth to flipper.

Remarks.—The smaller specimen had an aperture on the venter, anterior to the genital opening which had accommodated the umbilical cord. Because of the immaturity of this young porpoise, we supposed that young are born on the Arctic Coast of Alaska. We know of no other record of this species from so far north in North America as Point Barrow, Alaska.

The harbor porpoise occurs along the west coast of the Arctic Slope to as far north as Elson Lagoon east of Point Barrow. The cooler waters from the east which converge at Point Barrow with the warmer waters from the southwest may discourage the porpoise from going farther east. Pete Sovalik and Adam Levitt, now (1952) living at Barrow, say that harbor porpoises have been seen every year at Point Barrow and at Wainwright as long as the Eskimos can recall; only five or six, however, are seen in any one season.

The adult female obtained on August 6, 1952, had bones and otoliths of whitefish (*Leucichtys*) in the stomach. Circumstantial evidence suggests that the young porpoise taken on August 23, 1952, was the offspring of the adult taken on August 6. Several slitlike marks about 20 millimeters apart were on the back and sides of this young porpoise.

On August 1, 1937, Pete Sovalik observed two of the smallest porpoises he had ever seen (approximately one and a third meters long) in the quiet waters of the northwest part of Kugura Lagoon, NE of Wainwright. The two porpoises, with their backs exposed, were chasing fish in shallow water three meters from shore. These porpoises swam at great speed when he approached them by means of a boat. The large porpoise and two young seen in 1930 were in the same part of the lagoon as the two young porpoises seen in 1937.

The porpoises that have been seen at both Point Barrow and Wainwright mostly were in the northwest parts of lagoons or were dead on the ocean beach.

Adam Levitt stated that the straps, especially of adults, are the best parts of the animal to eat and that he had eaten a part of one this (1952) summer which was captured at Barrow Village.

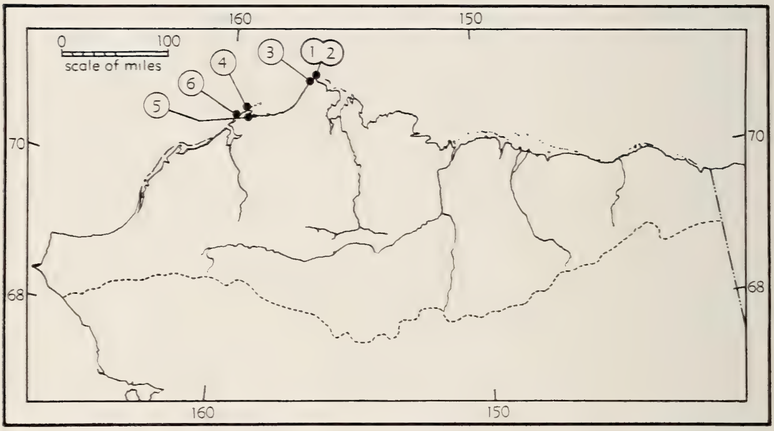


FIG. 72. Record stations of occurrence for *Phocoena vomerina.*

Records of occurrence.—Specimens examined, 2 (U.S.N.M.), Nos. 294800 and 294801. These are distributed by localities as follows: (1) northwestern extremity of Elson Lagoon, 156°20′00″, 71°21′30″ (captured by David Otoana on August 6, 1952—*fide* J. W. Bee, MS, 2 September 1952); (2) NW part of Elson Lagoon, 156°35′45″, 71°20′27″ (captured by the son of Clay Kaigelak on August 23, 1952—*fide* J. W. Bee, MS, 2 September 1952).

Additional records: (3) Barrow Village (seen by Pete Sovalik on several occasions in the last few years and one seen by Adam Levitt in summer of 1952—*fide* J. W. Bee, MS, 2 September 1952); (4) Atanik, 159°21′, 70°50′ (one found dead by Pete Sovalik on September 1, 1933—*fide* J. W. Bee, MS, 8 September 1952); (5) NW part of Kugura Lagoon, 159°17′00″, 70°47′30″ (one large and one small porpoise seen in 1930 and two young 1⅓ meters long seen on August 1, 1937, by Pete Sovalik—*fide* J. W. Bee, MS, 5 September 1952); (6) 11 mi. NE Wainwright, 159°39′, 70°47′ (one found dead by Pete Sovalik on September 1, 1933—*fide* J.W. Bee, MS, 5 September 1952).

Eschrichtius gibbosus (Erxleben)

Gray Whale (Agvikluak)

Balaena gibbosa Erxleben, Systema regni animalis . . . p. 610, 1777, type from Coast of New England.

Eschrichtius gibbosus van Deinse and Junge, Temminckia, 2:181, 1937. (Schevill, Breviora, Mus. Comp. Zool., 7:1-3, September 29, 1952, objects to *E. gibbosus* becauses it changes the currently used name *Rhachianectes glaucus* and Schevil recommends *Eschrichtius glaucus!*)

Rhachianectes glaucus, Cope, Proc. Acad. Nat. Sci. Philadelphia, 21:15, 1869. (Also Dall *in* Scammon, 1874:301; Elliot [spelling, *Rachianectes*], 1901:9; Bailey and Hendee, 1926:27; Anderson, 1947:91.)

Range.—Arctic Ocean.

Description.—Relatively slender; females as long as 45 feet, males smaller; dorsal fin absent; two longitudinal folds under throat about fifteen inches apart and six feet long; eyes above and behind angle of mouth; external ear about 2½ inches long; no dorsal fin (but back slightly humped); pectoral fin narrow; body pale, mottled grayish black; see fig. 69, page 161; mandible heavy and bowed outward; rostrum deep rather than broad; blubber 6 to 10 inches thick; nasals enlarged; no teeth; baleen approximately 15 inches long; spout quick and low.

Pete Sovalik told us that the gray whale is only occasionally taken or seen at Point Barrow.

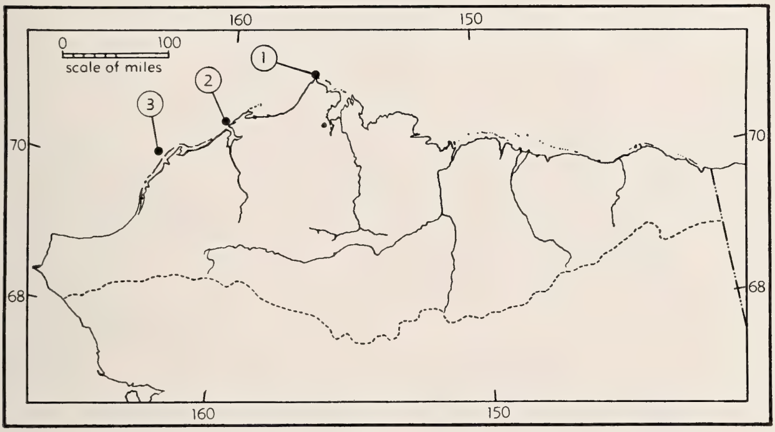


FIG. 73. Record stations of occurrence for *Eschrichtius gibbosus.*

Records of occurrence.—Specimens examined, none.

Records: (1) Point Barrow (reported by Pete Sovalik as uncommon—*fide* J. W. Bee, MS, 5 September 1952); (2) Wainwright (Bailey and Hendee, 1926:27); (3) Arctic seas (Dall *in* Scammon, 1874:301); Arctic Ocean (Elliot, 1901:9; Anderson, 1947:91).

Balaena mysticetus Linnaeus
Bowhead Whale (Agvik)

[Balaena] mysticetus Linnaeus, Systema naturae, ed. 10, 1:75, 1758, type from Greenland seas.

Balaena mysticetus, Godman, American natural history, Philadelphia, 3:98, 1826. (Also Armstrong, 1857:88; Murray, 1866:207; Dall *in* Scammon, 1874:305; True, 1884:591; Murdock *in* Ray, 1885:100; Nelson and True *in* Nelson, 1887:291; W. Stone, 1900:34; Elliot, 1901:8; Anderson *in* Stefansson, 1913b:496; Bailey and Hendee, 1926:23; Anderson, 1947:90.

Balena musticetus, Dufresne, Alaska's animals and fishes, A. S. Barnes and Co., New York, p. 182, 1946.

Range.—Arctic Ocean.

Description.—Length 50 to 65 feet; dark grayish brown; head large, more than ⅓ total length; lower mandible deep; rostrum high and arched; cleft of mouth a curved line (see fig. 69); nostrils paired; toothless; whalebone

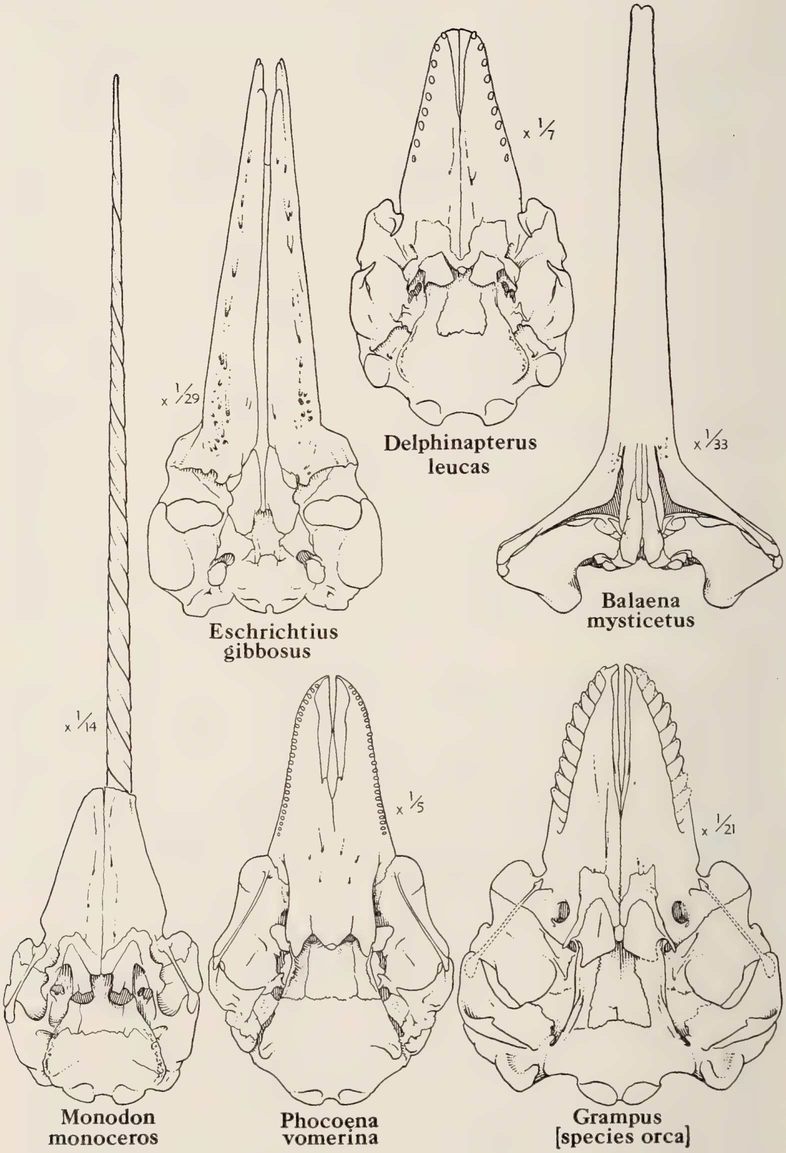

x 1/29
Eschrichtius gibbosus
x 1/7
Delphinapterus leucas
x 1/33
Balaena mysticetus
x 1/14
Monodon monoceros
x 1/5
Phocoena vomerina
x 1/21
Grampus [species orca]

FIG. 74. Ventral sides of skulls of six cetaceans (*diagramatic*).

present. Measurements made on September 11, 1952, of 34 rami (greatest height of ramus anterior to condyle of ramus, and 20 skulls (width across foramen magnum from lateral edges of exoccipital condyles), from abandoned dwellings and meat cellars at Point Barrow, are respectively, as follows: 277 (201-530), 331 (305-375). Of the 34 rami, the height of 27 ranged from 201 to 295 (mode 245), 5 ranged from 320 to 330, one measured 366, another 450, and largest was 530. Total lengths of two other medium-sized rami were 2556 and 2620. Least width between medial edges of posterior extension of squamosals, in seven skulls, ranged from 550 to 780. The greatest width across outer edges of glenoid fossae of the largest seven skulls at Birnirk Mounds was 1560. Greatest width of one scapula was 1300 mm.

Remarks.—From these measurements it is clear that Eskimos took principally young whales. In Eskimo houses at Birnirk, built at least a thousand years ago, skulls, ribs, vertebrae and scapulae of the whales were commonly used to support the roof and to make walls.

The bowhead whale is found throughout the open water of the Arctic Ocean and formerly was abundant. Its numbers have been greatly reduced. Thomas Brower believes that in spring the whales mistake the ice and snow on the shore line at Point Barrow for ice flows and move north and west into the Arctic Ocean. Because the season was at least 3 weeks late in the spring of 1952 the Eskimos at Point Barrow, on June 17, had not taken a whale. These Eskimos at that time were depending on the meat of whales that were taken at Wainwright.

On August 31, 1952, while flying north along the shore of the Arctic Ocean some eight miles south of Barrow Village, we saw whales, probably of this species. They were only one-fourth mile offshore in water so shallow that they stirred up mud as they swam near the surface of the water.

Records of occurrence.—Specimens examined, as above; none saved.

Records: (1) Point Barrow (Murdock *in* Ray, 1885:101; W. Stone, 1900: 34; Anderson *in* Stefansson, 1913b:497; Bailey and Hendee, 1926: pl. 4, fig. 7; Dufresne, 1946:182); (2) Cape Smythe (Murdock *in* Ray, 1885:100; Anderson *in* Stefansson, 1913b:497); (3) [definite localities unspecified] Arctic Ocean (Murray, 1866:53; Nelson and True *in* Nelson, 1887:291; Elliot, 1901: 9; Trouessart, 1904-05:789); Arctic seas (Dall *in* Scammon, 1874:305); circumpolar seas (Anthony, 1928:559; Burt and Grossenheider, 1952:166); seas to the northward of Bering's Strait (Godman, 1826:132); Icy Cape to mouth of Colville River (Nelson and True *in* Nelson, 1887:292); Arctic waters [from Cape Thompson to international boundary] (Anderson, 1947:90); (4) between Point Barrow and Return Reef (Murdock *in* Ray, 1885:101); (5) six miles out on Arctic from Wainwright (Bailey and Hendee, 1926:23, 26); (6) from Point Barrow to Point Hope (Nelson and True *in* Nelson, 1887:292); (7) in sight of Flaxman Island (Franklin, 1828:168 [probably this species]); (8) Point Hope (Anderson *in* Stefansson, 1913b:497; Rainey, 1940:362).

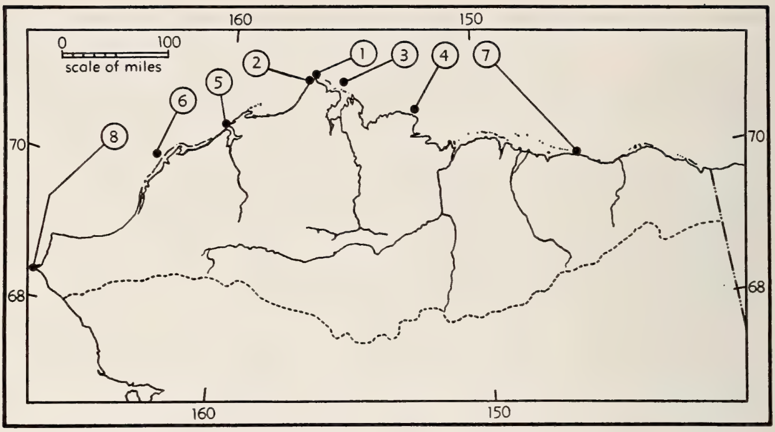


FIG. 75. Record stations of occurrence of *Balaena mysticetus.*

Canis latrans incolatus Hall

Coyote (Amagurak)

Canis latrans incolatus Hall, Univ. California Publ. Zool., 40:369, November 5, 1934, type from Isaacs Lake, 3000 ft., Bowron Lake region, British Columbia. (Also Jackson, 1951:262.)

Canis latrans, Dufresne, Alaska's animals and fishes. A. S. Barnes and Co., New York, p. 84, 1946.

Range.—Occasional on Arctic Slope.

Description.—This grayish, wolflike canid is smaller than the gray wolf but has relatively longer ears (for differences between the two species see description below and the key on page 268).

Males from Mount McKinley area (Dixon, 1938:163) measure as follows: Total length, 1248; tail, 408; hind foot, 212. Nose sharp and slender; ears large, sharp-pointed and erect; tail long, bushy and black-tipped; pelage grayish with admixture of black and buff; skull with large tympanic bullae; 42 teeth.

Remarks.—We tentatively employ the name *Canis l. incolatus,* until material is available from the Arctic Slope. Hall (1934:369) lists the range of *incolatus* as "at least as far as Wonder Lake, Mount McKinley district, Alaska." Jackson (1951:262) included the Arctic Slope within the range of *incolatus,* but without having examined material north of the Brooks Range. The specimens nearest to the Arctic Slope that have been critically examined, are from Kotzebue, Tanana and near Fairbanks, Alaska (see Jackson, 1951:262).

Pete Sovalik says that coyotes are occasionally seen on the tundra and in the Brooks Range and have always been present as far as he can remember.

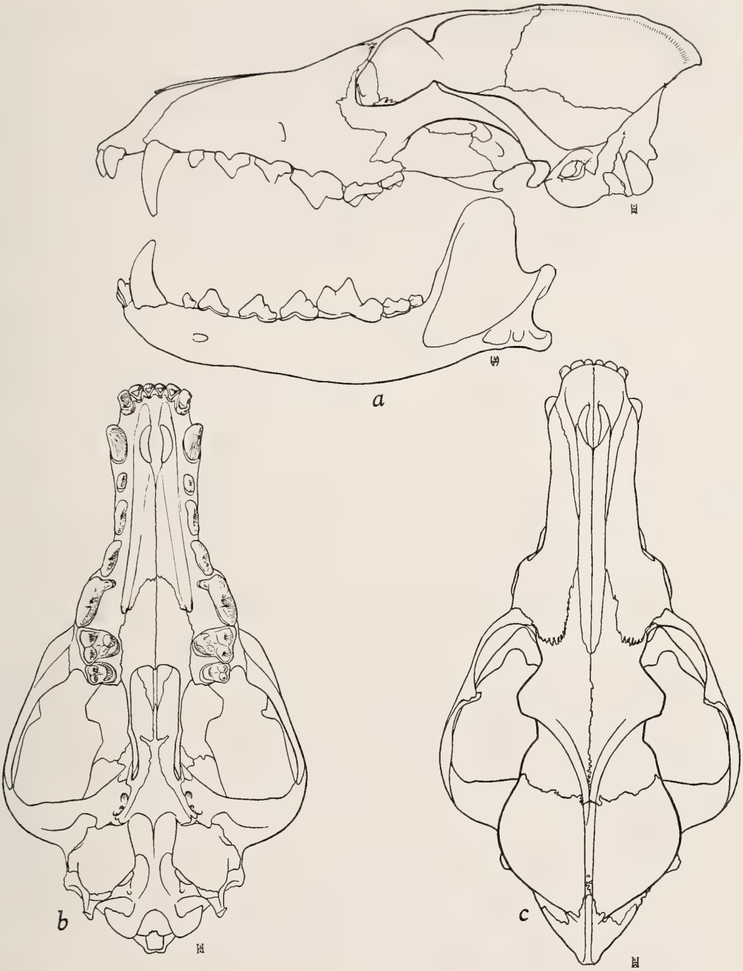


FIG. 76. Skull of *Canis latrans* [subspecies *lestes* Merriam], 5 mi. S Fallon, Churchill Co., Nevada, No. 89940 MVZ, ♂. × ⅖.

Records of occurrence.—Specimens examined, none.

Records: (1) Point Barrow (Dufresne, 1946:85; Jackson, 1951:263); (2) Arctic Slope [where on Arctic Slope unspecified but skin traded at Point Barrow (verbal information from Charles D. Brower, Sr., to E. Raymond Hall about 1935; Brower remembered receiving only the one skin at Point Barrow in his experience as trader up to that time)]; northern Alaska [locality from a general distribution map] (Dufresne, 1942:27); (3) Coastal Plain [where on Coastal Plain unspecified] (reported by Pete Sovalik—*fide* J. W. Bee, MS, 8 September 1952); (4) NE Alaska [locality from a general distribution map and represents 100 mammals] (Dufresne, 1942:27); (5) Brooks Range [where in Brooks Range unspecified] (reported by Pete Sovalik—*fide* J. W. Bee, MS, 8 September 1952); (6) Brooks Range [locality from a general distribution map and represents 100 mammals] (Dufresne, 1942:27).

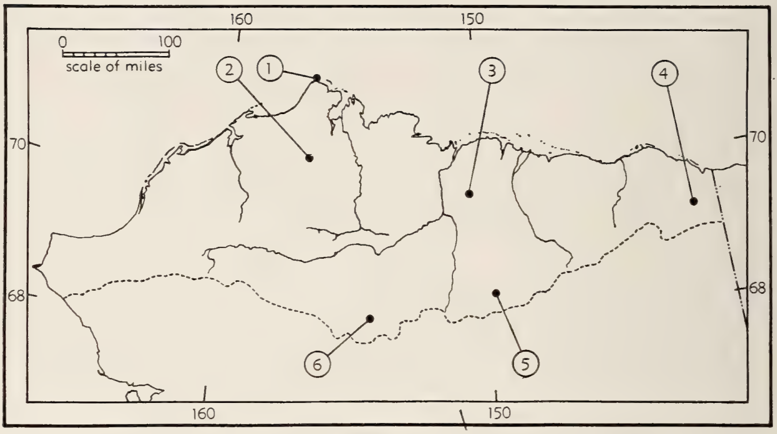


FIG. 77. Record stations of occurrence for *Canis latrans incolatus.*

Canis lupus tundrarum Miller
Gray Wolf (Amaguk)

Canis tundrarum Miller, Smithsonian Misc. Coll., 59 (15):1, June 8, 1912, type from Point Barrow, Alaska.

Canis lupus, var. *grisea,* Richardson, Zoology of Beechey's Voyage of H. M. S. Blossom, p. 5, London, 1839.

Canis occidentalis griseo-albus, Murdock, *in* Expedition to Point Barrow, Alaska, Exec. Doc. No. 44 (48th Congress, 2nd Session), by P. H. Ray, p. 93, 1885.

Canis lupus griseo-albus, Nelson and True *in* Arctic Series No. 3 of publication issued in connection with the Signal Service, U.S. Army, by Nelson, p. 233, 237, 1887. (Also Turner, 1886:208.)

Canis occidentalis, W. Stone, Proc. Acad. Nat. Sci. Philadelphia, 52:46, March 24, 1900. (Also Anderson *in* Stefansson, 1913b:516.)

Canis lupus tundrarum, Pocock, Proc. Zool. Soc. London, pt. 3, p. 681, 1935. (Also Anderson, 1937:108; 1943:387; Dufresne, 1946:80; Rausch, 1953:109.)

Canis lupus, Burt and Grossenheider, A field guide to the mammals, Hougton Mifflin Company, Boston, p. 51, 1952.

Description.—Largest of doglike carnivores on Arctic Slope; pelage varies from black to almost white and longest on neck and shoulders; tail bushy.

Measurements of an adult female (51561) from Wahoo Lake are as follows: Total length, 1500; tail, 390; hind foot, 280; ear from notch, 120; condylobasal length, 239; zygomatic breadth, 136; anterior width basioccipital, 19.2; orbital angle, 48°; palatal width between alveoli of first upper premolars, 31.5; alveolar length of maxillary tooth-row (P1 to M2), 86.7; palatal width as a percentage of length of tooth-row, 36.3; in lower jaw, distance between p1 and its opposite, 16.8; alveolar length of mandibular tooth-row (p1 to m2), 93.6; width between first lower premolars as a percentage of length of tooth-row,

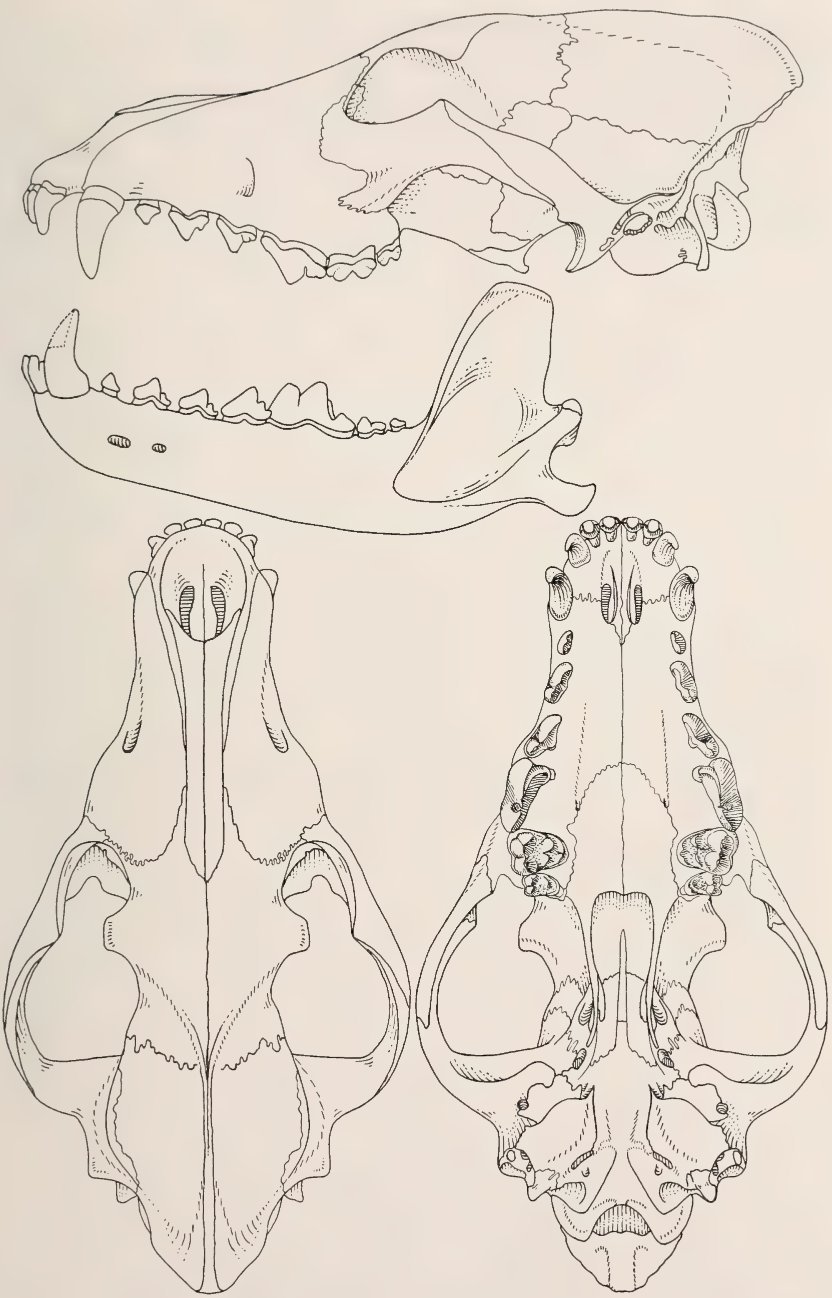


FIG. 78. Skull of *Canis lupus tundrarum,* Wahoo Lake, 146°58′, 69°08′, 2350 ft., Brooks Range, July 4, 1952, No. 51561 KU, ♀. × ⅖

17.9; weight in kilograms, 31.3 (69 lbs.). Pelage of adult female (51561 shot on July 9, 1952, at Wahoo Lake): upper parts from nape to rump Marguerite Yellow with admixture of near (17′ *n*) Mummy Brown, darkest on mid-dorsal line and thinning out along sides; sides like upper parts; underparts white with suffusion of Marguerite Yellow; inner sides of legs grayish white, outer sides of legs gray with suffusion of Marguerite Yellow; upper side of tail with proximal two-thirds like back except for fewer brownish black hairs, distally with black (instead of blackish brown) hairs but fewer than the brownish-black hairs on the basal two-thirds; tip of tail brown, underside of tail paler; chin and top of head grizzled; most of underfur of body vinaceous, especially between toes.

Remarks.—The Eskimo husky dog has considerable blood of the wolf; occasional wolves are captured, used in dog teams, and cross with huskies. Seven skulls of huskies (Eskimo dogs used for work) from Deadmans Island, however, could be distinguished from skulls of wolves by larger frontal protuberances, shorter muzzle, more obtuse orbital angle, wider basioccipital bone, lesser extension posteriorly of the inion and wider palate (between first premolars) relative to length of tooth-row (P1-M2).

The small breed of Eskimo dog (used for food several hundred years ago), has many cranial features (see figs. 78 and 79) that are characteristic of the wolf, but the skull of this breed of dog also definitely is of the domestic dog-type. Alaskan Eskimos no longer have dogs of this type.

Measurements of three skulls, of adults having worn teeth (51559, 51558, 51975), excavated from Eskimo mounds at Birnirk, show the uniformity in size and shape of the skull of this dog and are, respectively, as follows: condylobasal length, 168, 163, 164; basilar length (of Hensel), 154, 151, 151; zygomatic breadth, 92, ——, 95; interorbital breadth, 29.8, 28.2, 29.4; orbital angle, 48°, ——, 46°; mastoid breadth, 59.3, 56.4, 59.6; width of palate between first upper premolars, 26.9, 25.4, 27.4; alveolar length of tooth-row (P1 to M2), 60.2, 59.6, 61.5; palatal width as a percentage of length of tooth-row, 45, 43, 44; width of basioccipital anteriorly, 17.1, 16.7, 16.8. In the small dog, the orbital angle is nearer that of the wolf than that of the husky dog but the width of the palate between the first premolars, relative to the length of the tooth-row (P1-M2), is as in the husky dog. Immediately above the root of the zygoma the squamosal in the small dog is inclined dorsomedially (77°, 71°, and 79° from the horizontal) much as in the wolf and husky dog instead of being vertical (90° from the horizontal) as in the coyote and red fox.

The wolf is generally distributed throughout the Arctic Slope. Atanak, an Eskimo from Wainwright, says that wolves always have been common in the Kaolak River drainage. In the area east of this drainage, in 1000 square miles at the head drainage of the Colville River, Charles Hummel of the U. S. Geological Survey saw six different pairs of wolves in June and July of 1950. On the basis of 10 caribou that he found that had been eaten by wolves, he believed that there were more than six pairs of wolves in the area. William L. Wyatte, a surveyor at Umiat, told us that employees of the United States Fish and Wildlife Service killed a total of

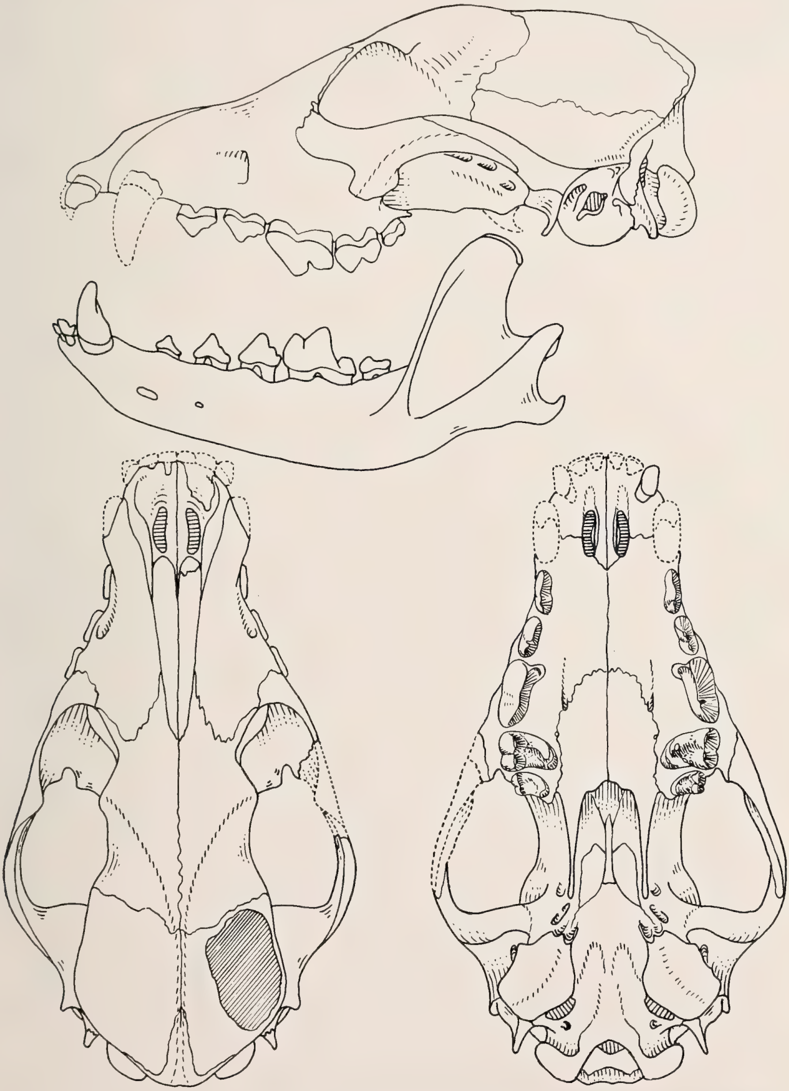


Fig. 79. Skull of *Canis familiaris,* Birnirk Mounds, House Q, 156°36′02″, 71°20′41″, 8 ft., Point Barrow, excavated September 4, 1952, No. 51559 KU, sex unknown. × ½.

275 wolves, including foetuses, east and south of Umiat in February and March of 1952. Later, in the spring of the same year, 74 females and 86 males were taken. As many as 20 were killed in one day. Norman Oie, who drove a caterpillar on the freight haul from Point Barrow to Umiat (*via* Smith Bay, Teshekpuk Lake, mouth of the Colville River to Umiat) in the winters of 1946 to 1949, told us that there were no wolves between Point Barrow and Sentinel Hill but that there were a few between Sentinel Hill and Umiat.

Wolves have been observed in nearly all physiographic types of habitat on the Arctic Slope from the low lying Coastal Plain to the high ridges in the Brooks Range. In the canyon south of Lake Peters and at various other places in the Brooks Range, wolves lived on the floors of the major canyons and followed paths of least resistance which were usually trails made and maintained by other animals, principally caribou. Tracks of wolves were seldom seen in small tributary canyons or high on the sides of the canyon beyond established trails except on narrow ridges. At Chandler Lake on August 12 fresh tracks were noted, in trails made by caribou, from the sands at the edge of the lake to the base of the precipitous slopes of the canyon.

The wolf is less restricted to any one community or association than are smaller mammals. We observed it in all successional stages as well as in the climax, although it was seen more frequently where populations of small mammals and birds were highest. The availability of food attracts the wolf and the stage of the population cycle of the prey species determines the community used by the wolf at any particular time. According to Pete Sovalik:

> Wolves occasionally kill caribou, as do bears and wolverines also, by dropping on their backs from some elevation, such as a ledge, or the top of a bank but most commonly the caribou is run down. Two or more wolves will participate one at a time pursuing it. Before the caribou is pulled down, a wolf first seizes a hind leg, and when the caribou turns to defend itself the wolf seizes the throat. Ordinarily only a few seconds are required for the wolf to kill the caribou after having caught it. If a group of wolves are following a caribou, one pursues while the others follow and when the caribou is killed a call brings in the other wolves.

At Pitt Point, Clifford Fiscus observed the method described by Sovalik. One of two wolves first separated a caribou from the herd and then, after tiring the animal, grabbed it by the throat. The second wolf appeared after the first wolf had killed the caribou.

At Chandler Lake a caribou that had been eaten by wolves was almost completely consumed except for the head that still retained the hide and fur. A pile of feces of the wolf consisted of five segments and lay in an area 180 mm × 180 mm. Individual segments measured 80 × 25, 80 × 40, 110 × 50, 60 × 30 and 80 × 40 millimeters and weighed (dry) 170 grams. These droppings, which contained only caribou hair, were within two meters of the hide and blood -soaked ground where the caribou had dropped and were approximately five meters from some other parts of the body that had been disarticulated and scattered on the tundra. At Wahoo Lake on July 7, 1952, there were wolf droppings every 250 meters or so along the floor of any given canyon. Droppings usually were associated with caribou tracks. In a distance of seven miles in a canyon, from the south end of Lake Peters to Lake James Robert, in July we found seven dead caribou that had been partly eaten by wolves. Circumstantial evidence including the position of the carcasses, the disturbance of the ground and the position of the dead animals in relation to surrounding country, indicated that most of the caribou had first been injured when descending rock fields but some may have died natural deaths on the resting grounds. These caribou were from two herds of 23,000 that moved through the canyon. These observations, as well as many others which we made in the Brooks Range, are in line with the accounts of Eskimos who have hunted caribou all their lives. These Eskimos report that wolves occasionally kill healthy caribou but ordinarily kill only those that are physically incapacitated or eat those found dead. All the circumstances suggest a cleaning-up process, rather than one of active predation upon normally healthy animals. Eskimos say also that when caribou temporarily are absent from an area, wolves there lived on ground squirrels and small mice, especially when smaller mammals are abundant.

The greater part of the above mentioned herd of approximately 23,000 caribou started to move up the canyon south of Lake Peters between July 19 (at 11:00 p.m.) and July 21, 1952, and in due time went on south over the divide. On July 23 we observed tracks of wolves superimposed on fresh tracks made by these caribou. These wolf tracks probably were made as early as July 20. Approximately two weeks later, on August 8, tracks showed that wolves had moved down the canyon; remains of aged and young caribou showed that the wolves had fed on the caribou (presumably on weakened or dead animals) in this time. Evidently the wolves were large individuals; imprints of four front paws measured, 120, 140, 140 and 148 millimeters in length. One imprint, 140 millimeters long, was 100 millimeters wide. The imprint of the hind foot of this same individual was 125 millimeters long and 93 millimeters wide.

At Kaolak River on July 12, 1951, we walked a half mile up the valley and upon our return found the imprints of a wolf that had passed within 17 meters of the tent and that had stepped in tracks made by us in the sand along the edge of the river only an hour and a half earlier. This wolf had been in the willows along the river. Later another, smaller, wolf left the willows, using the same avenue of escape along the sands at the edge of the river. These wolves had made six excavations for ground squirrels on the sand dunes among the willows. The imprint of the front foot of the largest wolf at these diggings measured 130 millimeters long. Associated with the tracks of the wolves were tracks of two red foxes, and two sets of tracks of whistling swan, which had cygnets approximately one mile down the river.

At Kaolak, on July 20, 1951, a wolf followed for at least one and a half miles along the edge of a creek, which was some 5 meters below the level of the tundra. This creek was lined with willows, some seven feet tall, which supported approximately 200 redpolls, 10 Alaskan longspurs, 80 savanna sparrows, six ptarmigans, six pintail ducks and several unidentified birds. Fresh tracks of caribou and red fox also were found along the edge of the creek.

In the canyon south of Lake Peters the wolf, unlike the bear, was selective in choosing a route across wet and muddy places on the floor of the canyon; the wolf used dry ridges, rocky outcroppings and grassy hummocks.

At Weasel Point, 60 meters south of Lake Peters at eleven o'clock at night in a drizzling rain, we witnessed the reactions of a wolf as it encountered man for perhaps the first time. The skies were heavily overcast and the temperature 34°F. The observer, wearing dark trousers, a dark parka with the hood down over most of his face and a yellow trap bag suspended from his shoulder may have resembled a caribou. The wolf was first observed 120 meters away as it stood on the bank of a creek that ran along the base of the ledge at Weasel Point. At that distance the wolf looked like a grizzly bear and the observer started back to camp! When seven meters nearer camp the observer looked back and recognized the animal as a wolf instead of a bear. The observer stopped and remained motionless. The wolf advanced to within approximately 90 meters, stopped for six seconds and then made a quick challenging charge of three meters, seemingly to test the reaction of its potential prey. The wolf walked back to the point where it first was observed, crossed the creek and started toward the observer again. In the meantime the observer had moved 30 meters closer to the wolf. The wolf on the second approach came within 50 meters and after inspecting the observer for 20 seconds, returned again to Weasel Point. The wolf's third attempt brought it to within 80 meters of the observer and after it had satisfied its curiosity it walked back to a point across the creek from where it was originally observed, and, climbing up through a fissure, reached the top of the ledges 4 meters high and disappeared from view. The observer then went over to the base of the ledge to inspect a trap that had been placed at the bottom of the same fissure which the wolf had just used. Glancing upward, only 4 meters away, the observer saw the eyes of a wolf peering over the edge of the ledge. It immediately left and continued up the canyon. This wolf was more curious than afraid and at no time ran. Its front track measured 120 mm. Possibly the wolf that peered over the top of the ledge directly above the observer was ready to spring on some prey, and was a hunting partner of the wolf which repeatedly may have attempted to lure the observer to the base of the ledge.

At 10:30 p.m. on July 9, 1952, an adult female wolf came into our camp at Wahoo Lake. She was 15 meters from a point visited by a grizzly bear five days earlier. Both the grizzly and the wolf came at approximately the same time of night when the only sunlight was on the upper peaks. The wolf was seen first as we were coming off the lake in a boat. She was sitting on the edge of a benchland used as our toilet area 90 meters from our tent. This benchland was two meters higher than our camp on the edge of the lake. The sounds from our talking and rowing of the boat and our scent were carried downwind to this wolf. While one observer (Edward Campbell) stalked to within firing distance, the wolf rolled over several times and then walked down to the base of the benchland where she rolled over again. These were places where there was human excrement. From a distance of 30 meters, a shot was fired which missed. She paid no attention to the report, to the disturbance made by the bullet that hit the bank directly above her, or to our movements, but rolled over again. A second shot missed but caused her to move up onto the benchland where she stood watching us until a third shot struck and disabled her.

At Kaolak on July 15, 1951, the camp cook saw two wolves feeding at the refuse pile approximately 200 meters from camp. Other wolves, on other occasions prior to July 15, were seen there—usually at about two o'clock in the morning.

Skulls, of wolves, which seemed to have been used for food by the Eskimos who had inhabited Point Barrow hundreds of years ago, were picked up from the Birnirk Mounds. One skull taken from a previously (in the last ten years) inhabited Eskimo camp at Chandler Lake was from a wolf that also seemed to have been used for food; one side of the braincase had been broken out suggesting that the brain had been removed.

Eskimos reported having seen packs of as many as 10 to 15 wolves. Groups of from two to six wolves were reported by white men on the Arctic Slope in the summer of 1952. On July 21, 1951, on the south side of the Brooks Range approximately 15 miles up the John River, Marvin Mangus saw a pack of 30 wolves. On another trip he saw the same pack in the same area. Mangus also saw six wolves near the mouth of Aupuk Creek on April 10, 1949, and six other wolves in the same area on the same date three years later.

Only one den was examined by us and it had been abandoned. It had been dug into a high sandy knoll that supported willows and other vegetation at Kaolak River. Other dens were observed by us from the air on cut banks of rivers between Umiat and Lake Schrader.

One skull, measuring 225 millimeters in condylobasal length, of a juvenile from Chandler Lake, had deciduous teeth being replaced by permanent teeth.

Records of occurrence.—Specimens examined, 3: Nos. 51561; skulls only 51560, 51978. These are distributed by localities as follows: (41) Wahoo Lake, 146°58′, 69° 08′, 2350 ft., Brooks Range, 1; (44) Driftwood, Utukok River, 161°10′12″, 68°53′47″, 1200 ft., Brooks Range, 1; (54) Chandler Lake, 152°45′, 68°12′, 2900 ft., 1 (see also Rausch, 1953:109).

Additional records: (1) Point Barrow (Murdock *in* Ray, 1885:93; W. Stone, 1900:46; Miller, 1912a:1; 1912b:79; Anderson, 1937:108;1947:57); (2) Pitt Point (seen by Clifford Fiscus in summer of 1952—*fide* J. W. Bee, MS, 8 Sept. 1952); (3) Meade River, near Point Barrow (Young and Goldman, 1944:418); (4) near Meade River (Murdock *in* Ray, 1885:93); (5) Wainwright (Rausch, 1953:108); (6) NE Teshekpuk Lake, 153°05′40″, 70°39′40″ (tracks noted 29 July 1951—*fide* J. W. Bee, MS, same date); (7) Pingok Island, 149°05′, 70°35′ (seen by William Irving and Joash Tukle, 5 July 1952—*fide* J. W. Bee, MS, 8 September 1952); (8) 60 mi. S Barrow (Rausch, 1953:109); (9) mouth Colville River, 151°12′, 70°14′ (a young wolf two weeks old seen by William Irving and Joash Tukle, 2 August 1952—*fide* J. W. Bee, MS, 8 September

1952); (10) Kaolak River, 159°47′40″, 70°11′15″ (tracks noted on 12 July 1951–*fide* J. W. Bee, MS, same date); (11) mouth Avalik River, 159°35′, 70°07′ (tracks noted by Atanak and party on 17 July 1952–*fide* J. W. Bee, MS, same date); (12) Colville River, 151°00′00″, 70°06′30″ (eight seen by Clifford Fiscus, 27 April 1952–*fide* J. W. Bee, MS, 8 September 1952); (13) Topagaruk River, 155°13′, 70°02′ (four adults, three gray and one black, seen by Max Brewer, 5 Sept. 1952–*fide* J. W. Bee, MS, 8 Sept. 1952); (14) Kaolak, 160°14′51″, 69°56′00″, 178 ft. (tracks noted 17 July 1952–*fide* J. B. Bee, MS, 8 Sept. 1952); (15) Point Lay (Rausch, 1953:109); (16) Hulahula River (Anderson, 1943:516); (17) East Fork Saviovik River, 146°49′, 69°39′ (two adults seen by Marvin Mangus, 1 July 1947–*fide* J. W. Bee, MS, 8 September 1952); (18) Sentinel Hill, Colville River, 151°04′, 69°36′ (seen by Norman Oie, winters of 1946-47-48-49–*fide* J. W. Bee, MS, 26 July 1951); (19) Meade River, 157°32′, 69°33′ (four adults seen by Marvin Mangus, 15 April 1949–*fide* J. W. Bee, MS, 8 September 1952); (20) Meade River, 157°58′00″, 69°32′50″ (a family of a male and female and six pups seen by Charles W. Whittington, 5 August 1949–*fide* J. W. Bee, MS, 8 September 1952); (21) Tooloouk, in a deep valley just off the Titivluk River (wolf skins for trade seen here on April 22, 1886 by Stoney, 1899:813); (22) Hulahula River, 144°20′, 69°29′ (seen by Charles W. Whittington, 28 June 1948–*fide* J. W. Bee, MS, 8 September 1952); (23) Okpilak River 144°02′, 69°27′ (seen by Charles W. Whittington, 15 June 1948–*fide* J. W. Bee, MS, 8 September 1952); (24) Titaluk, 154°32′, 69°26′ (seen by Max Brewer–*fide* J. W. Bee, MS, 5 September 1952); (25) Okpilak River, 144°03′, 69°25′ (seen by Charles W. Whittington, 15 June 1948–*fide* J. W. Bee, MS, 8 September 1952); (26) [definite localities not specified]: [Arctic Slope] (Anderson, 1943:387 [locality from figure]); all the mainland of Alaska (Turner, 1886:208); Arctic Slope from vicinity of Wainwright to Canadian border (Dufresne, 1946:83); Arctic America (Anthony, 1928:155); Arctic Slope (Burt and Grossenheider, 1952:52); doubtless the whole northwest coast of America (Richardson, 1839:5); (27) Carbon Creek, 159°55′00″, 69°23′30″ (seen by Charles W. Whittington, 15 August 1950–*fide* J. W. Bee, MS, 8 September 1952); (28) 10 mi. E Umiat, 151°46′, 69°23′ (skull collected by Westley Redhead, February 1952–*fide* J. W. Bee, MS, 18 July 1952); (29) Sadlerochit River, 144°39′, 69°23′ (two adults seen by Marvin Mangus, 10 April 1949–*fide* J .W. Bee, MS, 8 September 1952); (30) Umiat,

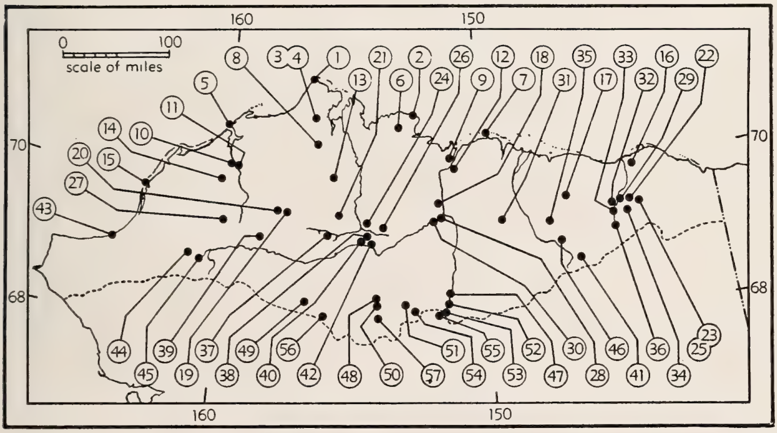


FIG. 80. Record stations of occurrence for *Canis lupus tundrarum*.

152°09′30″, 69°22′08″, 352 ft. (seen by William L. Wyatte, December 1951 –*fide* J. W. Bee, MS, 28 June 1952); (31) East Kuparuk River, 149°15′, 69°22′ (two adults seen by Marvin Mangus, 25 April 1952–*fide* J. W. Bee, MS, 8 September 1952); (32) Lake Schrader (Rausch, 1953:109); (33) Mount Mary, S end Lake Peters, 145°09′30″, 69°20′15″ (seen by J. W. Bee, 3 August 1952–*fide* J. W. Bee, MS, same date); (34) Hulahula River, 144° 34′00″, 69°19′50″ (seen by Charles W. Whittington, 18 June 1948–*fide* J. W. Bee, MS, 8 September 1952); (35) Ivashak River, 147°22′00″, 69°17′50″ (pack of eight adults seen by Marvin Mangus, 26 April, 1952–*fide* J. W. Bee, MS, 8 September 1952); (36) Lake James Robert, 145°10′, 69°06′ (seen by J. W. Bee, 8 August 1952–*fide* J. W. Bee, MS, same date); (37) Kigalik River, 155°59′, 69°15′ (seen by Charles W. Whittington, 15 August 1947 –*fide* J. W. Bee, MS, 8 September 1952); (38) Maybe Creek, 154°27′00″, 69°12′50″ (seen by Charles W. Whittington, 15 August 1951–*fide* J. W. Bee, MS, 8 September 1952); (39) Carbon Creek, 158°27′00″, 69°12′10″ (seen by Charles W. Whittington, 1 June 1949–*fide* J. W. Bee, MS, 8 September 1952); (40) near Colville River, 154°38′00″, 69°10′30″ (seen by Charles W. Whittington, 20 September 1951–*fide* J. W. Bee, MS, 8 September 1952); (42) Colville River, 154°20′00″, 69°07′30″ (six adults seen by Marvin Mangus, 10 April 1949 and 10 April 1952–*fide* J. W. Bee, MS, 8 September 1952); (43) Cape Beaufort ("recent tracks of wolves" seen by Beechey; 1831:370); (45) head Colville River [definite locality not specified] (10 adults in 1000 square miles seen by Charles Hummel in June and July of 1950–*fide* J. W. Bee, MS, 11 June 1952); (46) Mount Annette, 146°28′51″, 68°50′38″, approximately 5700 ft., Brooks Range (tracks and scat noted–*fide* J. W. Bee, MS, 17 July 1952); (47) Itikmalukpuk Creek (Rausch, 1953:109); (48) Killik River, 153°10′, 68°23′ (seen by Marvin Mangus, 20 August 1949–*fide* J. W. Bee, MS, 8 September 1952; Rausch, 1953:109); (49) Etivuluk River, 156° 45′00″, 68°21′20″ (two adults seen by Marvin Mangus, 30 May 1949–*fide* J. W. Bee, MS, 8 September 1952); (50) Killik River, 154°11′00″, 68°20′30″ (two adults and 3 pups seen by William Irving, 9 July 1951–*fide* J .W .Bee, MS, 8 September 1952); (51) Okmilaga River, 153°07′, 68°19′ (pack of 4 adults seen by Marvin Mangus, 10 June 1951–*fide* J. W. Bee, MS, 8 September 1952); (52) Tulugak Lake (Rausch, 1953:109); (53) mountain just north of the mouth of Anaktiktoak Creek (Rausch, 1951:173); (55) Anaktuvuk Pass (Rausch, 1953:109); (56) within 3 mi. of Itivlik Lake and northwesterly along the Ahlasuruk River for approximately 8 mi. (animals and dens–one den of 6 pups and another den of 2 or 3 pups– seen between June 19 and July 22 by Irving and Paneak, 1954:204); (57) Easter Creek, 154°08′, 68°07′ (adults seen by Marvin Mangus, 8 July 1952–*fide* J. W. Bee, MS, 8 September 1952).

Alopex lagopus innuitus (Merriam)
Arctic Fox (Tigiganiak)

Vulpes lagopus innuitus Merriam, Proc. Biol. Soc. Washington, 15:170, August 6, 1902, type from Karogar River, Point Barrow, Alaska. (Also Bailey and Hendee, 1926:15.)

Canis lagopus, Harlan, Fauna Americana, Philadelphia, p. 92, 1825.

Canis (*Vulpes*) *lagopus*, Richardson, Zoology of Beechey's Voyage of H. M. S Blossom, London, p. 5, 1839.

Vulpes lagopus, Murdock, *in* Expedition to Point Barrow, Alaska, by P. H. Ray, Exec. Doc. No. 44 (48th Congress, 2nd Session), p. 93, 1885. (Also Turner, 1886:208; Nelson and True *in* Nelson, 1887:233; W. Stone, 1900:46; Elliot, 1901:306; Stone and Cram, 1905:273.)

Alopex lagopus innuitus, Miller, U. S. Nat. Mus. Bull., 79:82, December 31, 1912. (Also Anderson *in* Stefansson, 1913b:517; Hall, 1929:421; Anderson, 1937:107; Barkalow, 1952:199; Rausch, 1953:107.)

Alopex lagopus lagopus, Dufresne, Alaska's animals and fishes, A. S. Barnes and Co., New York, p. 92, 1946.

Alopex lagopus, Strecker, Ryser, Tietz, Morrison, Jour. Mamm., 33:478, November 19, 1952.

Description.—Small (about 3½ feet over-all) fox, white in winter (rarely "blue") and brown in summer; ears short and rounded; muzzle short; pelage long and thick; tail bushy.

An adult female from Point Barrow measured: Total length, 1097; tail, 422; hind foot, 161; ear from crown, 56; weight, 2880 grams. Average and extreme cranial measurements in millimeters of 7 adult males and 5 adult females from within 10 miles of the Arctic Coast between Skull Cliff and Point Barrow, are, respectively, as follows (all specimens collected in February and in full pelage): Basilar length (of Hensel), ♂ 114.5(110.8-118.4), ♀ 111.5(108.8-115.5); zygomatic breadth, 68.8 (68.0-70), 67.3(65.8-69.8); mastoid breadth, 39.5(36.3-41.7), 39.8(38.6-41.9); width of anterior end of basioccipital, 9.3 (8.3-10.4), 9.9(9.1-10.8); greatest width of braincase, 46.2 (45.0-47.4), 45.6 (43.5-47.0); orbital angle, 48.8° (44°-51°), 47.8°(46°-49°); palatal width between alveolus of P1 and its opposite, 15.7 (15.0-16.4), 15.9 (14.7-17.0); alveolar length of tooth-row, P1-M2, 46.5(43.7-47.8), 45.2(44.0-46.4); palatal width as a percentage of length of tooth-row, 33.8(31.3-36.1), 34.5(33.4-36.6); in lower jaw, distance between p1 and its opposite, 8.8(8.0-9.5), 8.7(8.0-9.0); alveolar length of mandibular tooth-row, p1-m2, 49.9(47.6-50.7), 48.8(48.2-49.7); alveolar width between first lower premolars expressed as a percentage of length of tooth-row, 17.6(15.8-19.0), 17.7(16.5-18.5). Winter pelage white: guard hair straight, black and brown, white-tipped, confined to back and sides and nine-tenths as long as, but of greater diameter than, coverhair; coverhair white;underfur kinky; black underfur half as long as white underfur (but individual hairs of same diameter), giving gray appearance to white underfur; some of white underfur grading into coverhair. Summer pelage and blue phase not examined by us, but, according to W. Stone (1900:47) who examined specimens from Point Barrow, upper parts and outside of legs brown; sides, belly and inner sides of legs buffy white changing to vinaceous on breast and along edge of upper parts.

Remarks.—The Arctic fox is a circumpolar species that is common and widely distributed on the Arctic Slope, especially on the Coastal Plain near the Arctic Ocean. Charles Hummel of the U. S. Geological Survey in 1950 did not see this fox at the head of the Colville River in an area of approximately 1000 square miles. Rausch (1951:172), however, collected several specimens in the Brooks Range to the east. The Arctic fox inhabits the upland tundra of cotton-grass and the lowlands of sedges and grasses, and preys on small mammals, especially the brown lemming and collared lemming. Eskimos say that during winter the Arctic fox goes out on the ice pack and feeds on remains of seals killed by polar bears. The Arctic fox is well adapted to the climate of the Arctic Slope especially in winter when the fur becomes white and the feet and body are insulated by an exceptionally thick growth of woollike hair.

At Teshekpuk Lake, on July 29, 1951, Arctic foxes had excavated several nests of the collared lemming. Five or six narrow but deep holes usually were dug in an area of one square meter or so where the lemming lived. From subsurface runways and nests the fox removed the cover of vegetation by tearing it away by using the teeth rather than by digging with the feet. Some subsurface runways were exposed for one and one-half linear meters and mosses and lichens were scattered in all directions in the immediate area of the runways.

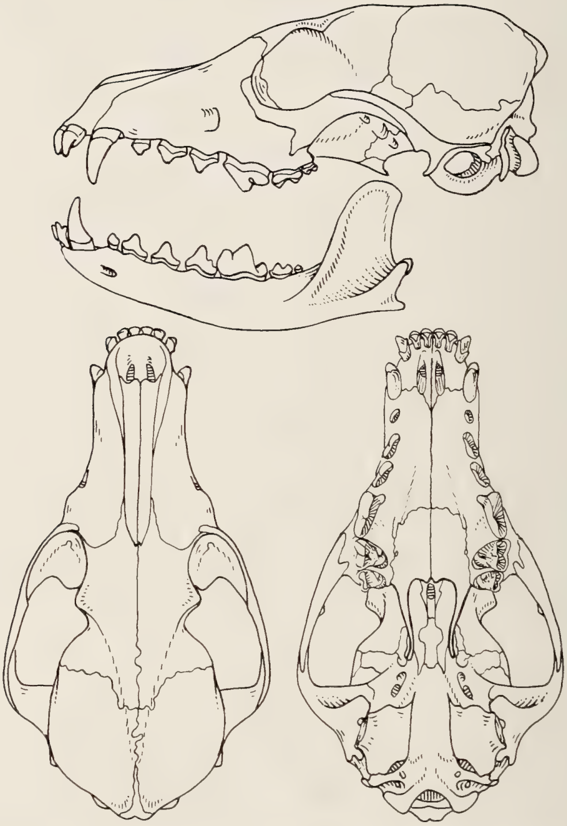


FIG. 81. Skull of *Alopex lagopus innuitus*, Point Barrow, February 1, 1952, No. 52366 KU, ♂. × ½.

A den that had been used by the Arctic fox at Teshekpuk Lake was in a bank only one meter high. This bank bordered a former bay that had been filled with silt. Tracks of wolf as well as of fox were in the silt nearby. Two skulls of Arctic fox and one snowy owl pellet that contained a radius and ulna of an Arctic fox lay near the den. One live fox was observed in a travel lane, made and used by caribou, between an old, sedge-filled lake and an adjoining lake. The fox seemed playful and was unafraid or curious but always kept ahead of us, using elevated hummocks for observation points. At Topagaruk on July 10, 1951, in a quadrat 700 × 2 meters, the Arctic fox had excavated 13 nests of the collared lemming and brown lemming.

Eskimos at Barrow Village claim that the Arctic fox increases when the lemming increases. In the winter and spring of 1953, in a period of high population of the lemming at Point Barrow, the Arctic fox increased in numbers. Max Brewer, U. S. Geological Survey, found the greatest concentration of Arctic foxes that he had ever seen on the Arctic Slope at Point Simpson and 20 to 30 miles to the southwest. On each of 28 different visits to these places he saw several Arctic foxes. One trapper at Point Simpson caught 20 with one trap in November and December of 1950.

> According to our Eskimo informant, Pete Sovalik, the hair of mammals becomes paler with continued exposure to the rays of the sun. For example the pelage of the Arctic fox changes to pure white only in early spring. This change caused by the sun's rays occurs also in the wolf which turns from dark grayish green on the tips of the hairs to white, and in the red fox which also becomes "whiter." Furs which are taken from animals in the autumn and winter and used for trim on parkas will remain the same color throughout the winter but in spring turn paler. There is no further color change in these parka furs in succeeding seasons.

Records of occurrence.—Specimens examined, 23: Nos. 52360, 52361; skulls only 51976, 52362-52374, 52376-52382. These are distributed by localities as follows: (2) near Point Barrow, 17; (3) ⅘ mi. S Barrow Village, 3; (4) 4½ mi. SE Barrow Village near Ikrowik Lake, 1; (7) about 35 mi. SW Point Barrow Village, near Skull Cliff, 1; (9) NE Teshekpuk Lake, 153°05′40″, 70°39′40″, 12 ft., 1.

Additional records: (1) Point Barrow (Karogar River) (Merriam, 1902:170; Miller, 1912b:82); Point Barrow (Murdock *in* Ray, 1885:93; Nelson and True *in* Nelson, 1887:233; W. Stone, 1900:46; Bailey and Hendee, 1926:15; Hall, 1929: 422; Brower, 1942:246; Dufresne, 1946:90; Rausch, 1953:107); (5) Woody Inlet (Murdock *in* Ray,1885:94); (6) Point Simpson, 154°35′, 71°00′ (seen by Max Brewer in November and December of 1950—*fide* J. W. Bee, MS, 5 September 1952); (8) Pitt Point (seen by Clifford Fiscus in summer of 1952—*fide* J. W. Bee, MS, 8 September 1952); (10) Meade River [unspecified] (Murdock *in* Ray, 1885:93), (11) Wainwright (Rausch, 1953:107); (12) Topagaruk, 155° 48′, 70°34′, 10 ft. (seen by Harry S. Newman in winter of 1950—*fide* J. W. Bee, MS, 25 July 1952); (13) [definite localities not specified] countries bordering on the frozen sea (Shaw, 1800:326); Arctic Coast (Anderson *in* Stefansson, 1913b:517; Anderson, 1937:107); Polar regions (Elliot, 1901:306); Arctic regions (Trouessart, 1904-05:237; Stone and Cram, 1905:273; Arctic Alaska (Anthony, 1928:148); [Arctic Slope] (Burt and Grossenheider, 1952:52); from Alaska northwards (Richardson, 1839:5); more northern portions of the mainland [of Alaska] (Turner, 1886:208); countries bordering on the frozen ocean . . .of the continent of America (Harlan, 1825:93); between Point Barrow and 141st. Meridian (Leffingwell, 1919:66); (14) Barter Island (Strecker, Ryser, Tietz, Morrison, 1952:478; Barkalow, 1952:199); (15) Demarcation Point (Bailey and Hendee, 1926:15); (16) immediately north of mountains near Chandler Lake (Rausch, 1951:172); (17) Killik River [precise locality unspecified] (Rausch, 1951:172); (18) Itikmalukpuk Creek, NE of Anaktuvuk Pass (Rausch, 1953:107); (19) Agiagiak Creek (Easter Creek) (Rausch, 1950c:465; 1951:172); (20) April Creek, Brooks Range (Rausch, 1951:172).

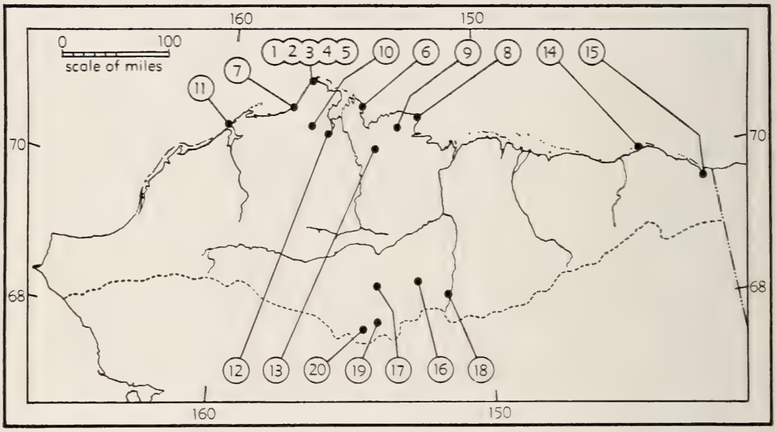


FIG. 82. Record stations of occurrence for *Alopex lagopus innuitus.*

Vulpes fulva alascensis Merriam

Red Fox (Kayuktuk)

Vulpes alascensis Merriam, Proc. Washington Acad. Sci., 2:668, December 28, 1900, type from Andreafski, Alaska. (Also Bailey and Hendee, 1926:15.)

Vulpes fulvus, Murdock *in* Expedition to Point Barrow, Alaska, by P. H. Ray. Exec. Doc. No. 44 (48th Congress, 2nd Session), p. 93, 1885.

Vulpes fulvus argentatus, Murdock *in* Expedition to Point Barrow, by P. H. Ray. Exec. Doc. No. 44 (48th Congress, 2nd Session), p. 93, 1885. (Also Nelson and True *in* Nelson, 1887:233.)

Vulpes fulvus fulvus, Turner, Arctic Series No. 2 of publications issued in connection with the Signal Service, U. S. Army, p. 208, 1886.

Vulpes fulvus decussatus, Nelson and True *in* Arctic series of publications No. 3 issued in connection with the Signal Service, U. S. Army by Nelson, p. 242, 1887.

Vulpes alascensis alascensis, Miller, Bull. U. S. Nat. Mus., 79:84, December 31, 1912. (Also Dufresne, 1946:89.)

Vulpes fulva alascensis, Hall, Univ. California Publ. Zool., 30:421, March 19, 1929. (Also Rausch, 1951:171.)

Vulpes vulpes alascensis, Rausch, Arctic, 6:107, July, 1953.

Vulpes fulva, Burt and Grossenheider, Field guide to the mammals, Houghton Mifflin Co., Boston, p. 48, 1952.

Description.—General coloration red; tail white-tipped. Color varies but little seasonally (is not white in winter), but there are three color phases as described below.

Measurements of two adult males (52358 and 52435) and three adult females (52359, 52385, 52384), from within 80 miles of Point Barrow, are, respectively, as follows: Total length, ♂ ———, ♀ 1005 (924-1087); tail, ———, 289(357-422); hind foot, ———, 146(132-161); basilar length (of Hensel), 136(132-140), 131(123-141); zygomatic breadth, 80.4 (80.0-80.7), 75.3(75.0-84.2); mastoid breadth, 46.8(46.0-47.7), 43.0(40.6-45.0); anterior width of basioccipital, 12.9(12.3-13.5), 12.1(11.3-13.4); greatest breadth of braincase, 50.9(49.9-51.9), 48.0(46.5-51.3); orbital angle, 41.0°(38.0°-43.0°), 42.3° (39.0°-45.0°); palatal width between alveoli of P's 1, 17.0(16.2-17.9), 16.5 (14.8-17.8); alveolar length of maxillary tooth-row (P1 to M2), 57.3(56.8-57.9), 53.8(50.1-56.5); palatal width as a percentage of length of tooth-row, 29.6 (27.0-27.0), 30.6(29.5-31.3); in lower jaw, distance between p1 and its opposite, 8.9(8.9-8.9), 8.4(8.1-8.8); alveolar length of mandibular tooth-row (p1-m2), 60.7(60.0-61.3), 57.5(53.4-61.9); width between p1 and its opposite as a percentage of length of tooth-row, 14.7(14.5-14.8), 14.6(14.1-15.1); weight in gms., ————, 4670(3700-5640).

Pelage of an adult female (52437, obtained on March 15, 1953, near the coal mine along Meade River, 80 miles S Point Barrow): shoulders and mid-dorsal line on neck and back near (11 *l*) Auburn; hair on rump coarse, grizzled and near (17″*e*) Cinnamon-Buff, remainder of upper parts Buckthorn Brown; top of tail like upper parts but with patches and admixture of black hairs, tail underneath paler and with fewer black hairs, tip of tail white at all seasons; outside of ears black; face grizzled with white and nearly white on upper lips; middle third of venter Mummy Brown becoming grayish white anteriorly on chest and neck and Pale Vinaceous Fawn with admixture of black posteriorly to base of tail and on proximal parts of inner sides of legs; top of forefeet from base of claws to point between carpus and knee, black; black of hind legs less extensive and confined to top of feet and narrow stripe above metatarsals. A female trapped on November 20, 1953, has brighter red pelage and more nearly white chest, chin and posterior underparts than the one trapped in March. In general terms this fox is large, reddish-yellow, with mid-dorsal line slightly darker; hair on anterior back long and silky; hair on posterior back short and coarse; tail long, bushy and tipped with white regardless of whether animal is in red, cross, black or silver phase; sexes colored alike and varying only slightly seasonally; scent gland at base of tail.

The red fox is common and is widely distributed on the Arctic Slope. It has a more general distribution and seldom is as abundant locally as is the Arctic fox. In contrast to the Arctic fox, which usually inhabits open and exposed tundra, the red fox prefers broken country such as hillsides and sides of valleys or canyons. Charles Hummel saw five pairs of red foxes in an area of approximately 1,000 square miles at the headwaters of the Colville River in 1950. Two red foxes were observed at Topagaruk in 1950 by Harry S. Newman; they were seen nearly every day throughout the winter but left about May 1 and were not seen in summer. Clifford Fiscus told us that red foxes were common at Pitt Point in the summer of 1952. Red foxes were seen frequently at Point Barrow by Max Brewer. He also observed one at 1¼ miles south of Barrow Village in April, 1951, and another near the Meade River approximately 40 miles south of Point Barrow on July 11, 1951.

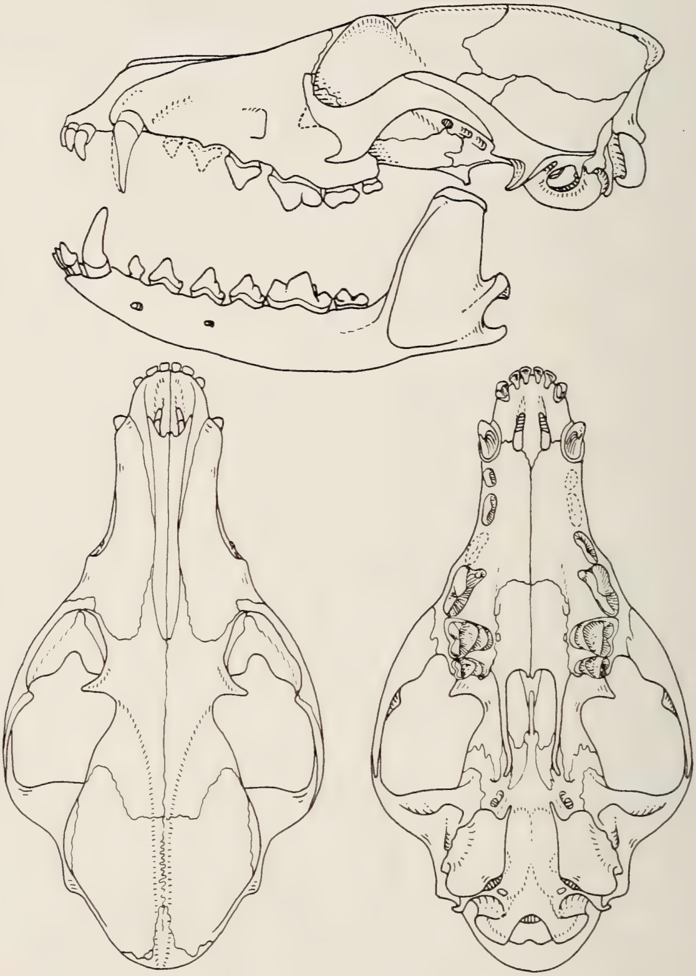


FIG. 83. Skull of *Vulpes fulva alascensis,* along Meade River near coal mine, 60 mi. S Point Barrow, April 18, 1953, No. 52436 KU ♀. × ½.

Tracks of the red fox were seen commonly by us at Kaolak along willow-lined creeks protected from winds. These riparian communities had a higher percentage of smaller birds than did the open tundra. On the sands on the west side of the Kaolak River opposite Anaktuk, tracks of the red fox were more numerous than those of the wolf, caribou and ground squirrel. Atanak, an Eskimo from Wainwright, told us that red foxes were numerous here a few years ago. They were uncommon in 1951, however, possibly following the trend in numbers of the brown lemming and collared lemming that were low there in 1951.

Approximately 150 meters west of the mouth of Bearpaw Creek at Umiat on July 27, 1952, a red fox left the base of a ledge 2 meters high on the north side of the valley. The fox ran to the ridge above and crossed about 300 meters of open upland tundra to a canyon to the north. Later we found a den used by a red fox in this canyon.

A family of five red foxes was seen three times at Driftwood between August 28, and 31. Sets of tracks of 4 subadults and one adult frequently were found together on the sands of creeks that flowed among the willows on the floor of the valley. Three subadults were observed along the willow-lined edges of a river bed of gravels and sands. According to the men at the Driftwood camp, red foxes remain in the general area of the camp and their whereabouts could be ascertained by the warning calls of the ground squirrels.

One mile east of Barrow Village, W. H. Craig killed a red fox because it was chewing the insulation on cable leads. At Umiat on July 21, 1953, Starker Leopold saw a red fox that had a brown head and black body. This animal was seen first on sands along the Colville River but ran into bordering willows and alders. Red, black, silver and cross foxes were seen at Pitt Point in the summer of 1952 by Clifford Fiscus.

Records of occurrence.—Specimens examined, 9: Nos. 52384, 52437: skulls only, 51977, 52358, 52359, 52375, 52385, 52435, 52436. These are distributed by localities as follows: (1) near Point Barrow, 1; (2) approximately 150 yards from ocean 1 mi. SW Point Barrow Camp, 1; (6) coastal bluff near Skull Cliff, approximately 35 mi. SW Point Barrow, 1; (12) near Meade River, 60 mi. S Point Barrow, 2; (13) near coal mine on Meade River, approximately 70 mi. S Point Barrow, 1; (16) near coal mine along Meade River 80 mi. S of Point Barrow, 2; (17) Kaolak River, 159°47′40″, 70°11′15″, 30 ft., 1.

Additional records: (3) Barrow (Bailey and Hendee, 1926:15; Hall, 1929: 421; Brower, 1942:277); (4) 1¼ mi. S Barrow Village (seen by Max Brewer on April 15, 1951—*fide* J. W. Bee, MS, 5 September, 1952); (5) [3 to 4 miles] south of Cape Smyth (Beechey, 1831:433); (7) Pitt Point (seen by Clifford Fiscus in summer of 1952—*fide* J. W. Bee, MS, 8 September 1952); (8) 43 mi. S Point Barrow, Meade River (seen by Ira L .Wiggins—*fide* J. W. Bee, MS, 11 July 1951); (9) NE Teshekpuk Lake, 153°05′40″, 70°39′40″ (seen by J. W. Bee—*fide* J. W. Bee, MS, 29 July 1951); (10) Wainwright (Bailey and Hendee, 1926:15; Rausch, 1953:108); (11) Topagaruk, 155°48′, 70°34′ (seen by Harry S. Newman in winter of 1950—*fide* J. W. Bee, MS, 25 July 1951); (14) Icy Cape (Bailey and Hendee, 1926:15); (15) Fish Creek Camp, 152°00′00″, 70°18′40″ (seen by Harry S. Newman in winter of 1951—*fide* J. W. Bee, MS, 25 July 1951); (18) Colville River, 151°24′, 70°05′ (seen by Clifford Fiscus on April 30, 1952; Eskimos reported others—*fide* J.W. Bee, MS, 8 September 1952); (19) Kaolak, 160°14′51″, 69°56′00″ (seen by J. W. Bee, 25 July 1951); (20) near the hill Nuasuknan. . .close to the upper Meade River [estimated position on our map] (Murdock *in* Ray, 1885:93; Nelson and True *in* Nelson, 1887:233); (21) 1 mi. S and ½ mi. W Umiat, 350 ft. (seen by Starker Leopold—*fide* J. W. Bee, MS, 21 July 1952); (22) 1⅖ mi. N and 1$\frac{3}{10}$ mi. E Umiat (seen by J. W. Bee, 27 July 1952); (23) [definite localities unspecified]: All the mainland except that part immediately adjacent to the north coast (Turner, 1886:208; along the coast [of Arctic Slope] (Leffingwell, 1919:66); northern Alaska (Miller, 1912b:84; 1924:145); (Anthony, 1928:140); entire mainland area of Alaska (Dufresne, 1946:87); northern Alaska [Arctic Slope] (Burt and Grossenheider, 1952:49); (24) near Cape Beaufort (Bailey and Hendee, 1926:15); (25) Driftwood, Utukok River, 161°12′10″, 68°53′47″, 1200 ft. (seen by J. W. Bee, MS, 27 August 1952); (26) head Colville River [unspecified] (seen by Charles Hummel in June and July, 1950—*fide* J. W. Bee, MS, 11 June 1952); (27) Ivashak River, 146°39′15″, 68°51′12″ (seen by William P. Brosge—*fide* J. W. Bee, MS, 12 July 1952); (28) Chandler Lake (Rausch, 1953:108); (29) Okominilaga Creek (Rausch, 1953:108); (30) Anaktuvuk Pass (Rausch, 1951:172; 1953:108).

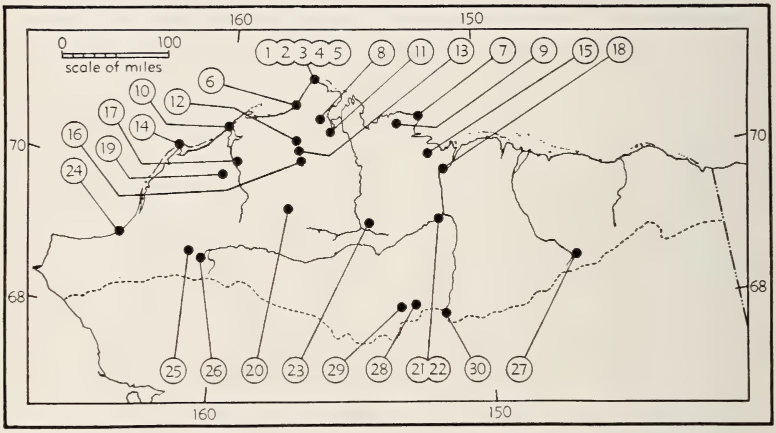


FIG. 84. Record stations of occurrence for *Vulpes fulva alascensis.*

Ursus horribilis richardsoni Swainson

Grizzly Bear (Aklak)

Ursus richardsoni Swainson, Animals in menageries (*in* Lardner's cabinet Cyclopaedia), 1838, p. 54, type near first cascade, about eight miles from mouth of Hood River, Arctic Sound, on west side of Bathurst Inlet, southeast of Coronation Gulf, Mackenzie. (Also True, 1884:608; Nelson and True *in* Nelson, 1887:233; Anderson *in* Stefansson, 1913b:519; Rausch, 1950c:465; 1951:165.)

Ursus arctos ?, Murdock *in* Expedition to Point Barrow, Alaska by P. H.

Ray. Exec. Doc. No. 44 (48th Congress, 2nd Session), p. 94, 1885. (Also Rausch, 1953:95.)

Ursus internationalis Merriam, Proc. Biol. Soc. Washington, 27:177, August 13, 1914, type from Alaska-Yukon boundary, long., 141° W, approximately 50 miles south of the Arctic Coast. (Also Merriam, N. Amer. Fauna,

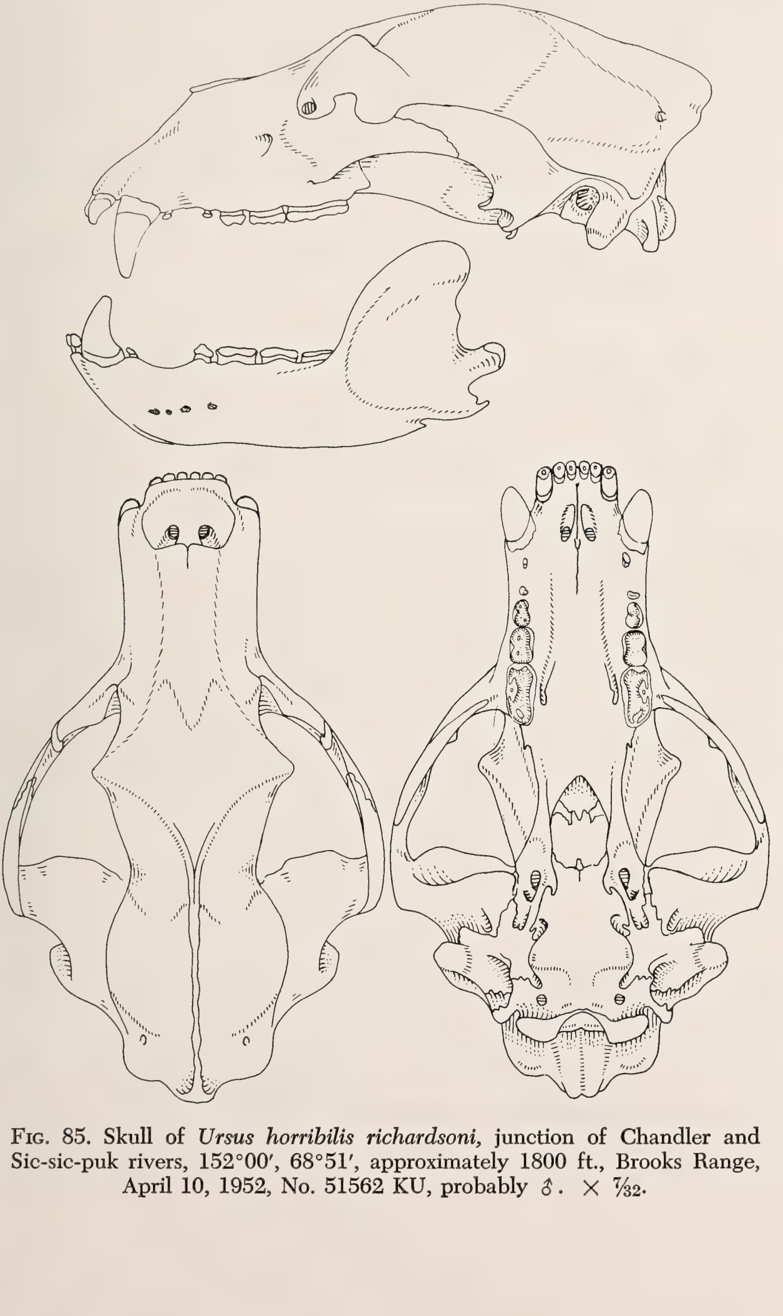


FIG. 85. Skull of *Ursus horribilis richardsoni,* junction of Chandler and Sic-sic-puk rivers, 152°00′, 68°51′, approximately 1800 ft., Brooks Range, April 10, 1952, No. 51562 KU, probably ♂. × 7/32.

41:103, February 9, 1918 [here tentatively arranged as a synonym of *U. h. richardsoni*]; Dufresne, 1946:57.)

Ursus alascensis, Bailey and Hendee, Jour. Mamm., 7:13, February 15, 1926.

Ursus internationalis internationalis, Anderson, Bull. Nat. Mus. Canada, No. 102, Biol. Series No. 31, p. 45, January 24, 1947.

Ursus arctos horribilis, Rausch, Arctic, 6:105, prior to October 2, 1953.

Description.—Large bear; males 1800 to 1900 millimeters (6 to 6⅓ ft.) in length and weighing 300 to 600 pounds; hump in shoulder region; tail rudimentary; eyes and ears relatively small; feet large, five-toed and plantigrade; claws on forefeet notably longer than on hind feet; claw of second digit of forefoot more, instead of less, than two inches (52 millimeters) long; pelage brownish or yellowish; skull dish-faced in lateral profile; last upper molar large (see fig. 85).

On the Arctic Slope most of the grizzly bears are in sheltered and vegetated valleys of the Brooks Range and broad Plateau Province and a few range onto the low Coastal Plain to within fifteen to twenty miles of the Arctic Ocean. Those on the Coastal Plain ordinarily are associated with areas of relief along river courses and with higher vegetation. The coast line seems to be avoided, perhaps because of the presence there of man or the polar bear or both. In the Brooks Range more bears and more tracks were seen in the intermontane valleys and at the headwaters of the major canyons which run north and south than elsewhere. Ralph Steiner reported a high population in the area of Lookout Ridge, Liberator Lake and Noluk Lake. Charles Hummel, while at the headwaters of the Colville River during June and July of 1950 observed ten adults and nine cubs in an area of approximately 30 by 35 miles. This area is east of Driftwood and includes a segment of the Brooks Range and a part of the Plateau Province between the crest of the Brooks Range and the Colville River. To the west between the Upper Utukok and the west fork of the Koblik from May 30 to September 1, 1950, Marvin Mangus saw approximately 30 individuals in an area of approximately thirty by thirty miles. In the eastern part of the Brooks Range at Porcupine Lake in an area six by two miles, on July 17, 1952, we noted 3 single adults, one female with two cubs and another female with three cubs. On the basis of the above figures of Hummel and Mangus there may be 1818 bears on the north slope of the Brooks Range and in the Plateau Province. Our figures indicate a higher number.

The Eskimos report that bears always have been as abundant as they are now and in the same region. Perhaps Anderson (1913b: 519) was not fully informed when he stated that grizzly bears are uncommon north of the Brooks Range, or he may have had in mind merely more dense populations south of the Brooks Range.

Although capable of traversing all physiographic types, the grizzly, in undisturbed areas, mostly frequents broad and gently sloping hillsides or level parts of the floors of valleys. On the Arctic Slope the bear is most abundant on the rolling benchlands in the east-west synclinal valleys of Permian formations in the Brooks Range. These intermontane valleys are bordered by high precipitous mountains of Lisburne limestone whose slopes, although covered with an abundant supply of food, are not commonly used by the bears. In canyons bordered by steep walls, the bears choose paths of least resistance; these are between the stream and the base of the walls of the canyon. Where there are pre-established caribou trails the bears use even the muddiest of these in preference to the tundra that is more difficult to negotiate.

The grizzly is exposed to most of the climates of the Arctic Slope and seems to be well adjusted to all of them. On July 17, 1952, at Porcupine Lake when the temperature mounted to 85°F the bears were active only in the morning and at night. The habit of denning up in winter permits the grizzly to avoid the coldest weather.

The omnivorous grizzly bear occurs in all plant and animal associations on the Arctic Slope. In summer these bears are more commonly observed along small streams lined with dwarf willow in the willow-singing vole association and in communities where ground squirrels live than elsewhere. These areas support most of the small mammals and birds as well as an abundance of grasses, sedges, berries, edible roots and a varied aquatic life. In their search for ground squirrels the bears occur in all of the successional stages of vegetation associated with the squirrel, from those on the sands along the edges of rivers to those on slopes high on the sides of mountains. The bears tend to use those habitats in which food is most easily obtained. One bear, for example, utilized a bare lane of mud flows that was easy to walk on, and there captured singing voles that lived on isolated hummocks of vegetation.

For two hours on July 17, 1952, at Porcupine Lake we watched a female and three small cubs grazing on a high benchland. In this time they moved approximately two hundred feet. Their actions suggested that they were feeding on last year's berries or other types of vegetation since the bears did no digging. At Wahoo Lake on July 4, 1952, William P. Brosge found fresh droppings that were green because of the contained plant material. In hunting for small mammals, or for roots and other plant foods, the bear dislodges or destroys mosses, lichens, dwarf willows, shrubs and extensive patches of grasses. The most pronounced coaction is the covering of vegetation with the soil that the bear excavates in digging out ground squirrels and other small mammals. More vegetation is covered by soil on hillsides than is covered elsewhere because the slope assists the bear in removing and scattering the soil. If such excavation is continued over a wide area for a long time the community is changed from a climax to a successional stage.

In a distance of one mile, along the crest of a ridge leading north from Mount Annette, where ground squirrels were abundant there were 58 diggings made by bears. Twelve bushels of soil from one of these diggings covered an area of approximately six square meters. Digging for ground squirrels makes bare areas and brings large boulders to the surface.

On the floor of the canyon at Wahoo Lake, bears had dug into the ground for small mammals every 70 meters or so; some of the excavations were long, linear trenches. Frequently boulders weighing as much as 120 pounds were moved. We observed one old adult grizzly excavating ground squirrels from the banks of a willow-lined stream course. This bear had dug five or six holes and had removed several bushels of soil from an area of about two by three meters. The bear was first seen digging rather leisurely in one excavation; after working for about ten minutes the bear would stop and lie down for 15 to 20 minutes. This alternation of work and rest continued from three o'clock in the afternoon until seven o'clock that evening. How much earlier or later the bear was thus occupied we did not determine. We were impressed by the unhurried manner in which this bear excavated the squirrels. At Wahoo Lake we watched a grizzly dislodge singing voles and ground squirrels from isolated mounds of soil and vegetation by using the forefeet vigorously to shake the upper surface of a mound. Such mounds were agitated with a combination bear-hug and clawing motion. One bear shook a mound which supported an abandoned squirrel burrow, and dislodged a singing vole. The bear immediately pursued the vole across five meters of bare surface surrounding the mound but failed to capture the vole that took refuge in an adjacent mound. The bear may have been expecting a ground squirrel; at any rate the bear continued to another mound after the short pursuit. Bears frequently eat caribou. Tracks of bears often were superimposed on tracks of caribou and generally were headed in the same direction as the caribou. Bears as well as wolves ate caribou that had died while the herds were moving up the canyon south of Lake Peters. We frequently found bear-droppings composed of bone and hair of caribou near carcasses of these caribou.

According to Pete Sovalik: Bears occasionally kill caribou by pouncing on them from some elevation; in winter the bears move from the Coastal Plain to the mountains or Plateau Province, and feed on fish where there is open water in fast moving streams; at this time the fur of the bear becomes covered with a thick layer of ice; Eskimos armed with only bow and arrow refused to hunt these animals during the time when the bears were covered with this armor of ice, which might protect the animal from even a bullet of a small bore rifle.

Grizzly bears incur the enmity of man because they raid caches and uninhabited camps. Frank Cernick of the U. S. Geological Survey reported a dozen or so caches destroyed or damaged by bears. At Wahoo Lake we examined a gasoline drum of fifty gallons capacity, that bears had opened by forcefully bending the two free edges of the lid. The lid had been bolted down on two sides. All of the contents of this drum had been removed and individual items were either punctured or torn open by the bears' chewing a hole in the side of each box or can and then squeezing the contents out by pressure and distortion of the container. From the debris, which remained in a small area about 14 meters in diameter, surrounding the cache, we itemized the materials according to the selectivity of the bear. Foods not eaten were: canned green peas, dry beans, dry peas, candy bars, jam, canned gooseberries, canned peaches, canned pineapple juice, canned grapefruit, canned asparagus, canned corn, gasoline stove fuel, kerosene, and dill pickles. Foods eaten were: white flour, canned rye bread, crisco, butter, dry eggs, Aunt Jemima pancake flour, cream of wheat, pie mix, corn beef hash, canned chicken. It seemed the bears preferred cereals and refused foods high in sweet- or acid-content.

If the shooting of these animals is allowed to continue their numbers will become greatly reduced. In areas where there are many white men, certain conservation measures need to be taken at once to preserve the bear. Supplies and equipment could be bear-proofed and certain areas could be set aside as inviolate sanctuaries. In primitive areas where bears are found in normal numbers and unmolested they inspect man at 10 meters with a fearless unconcern, and man, not the bear retreats. In areas where bears have been hunted or molested, as in the Chandler Lake area, they are seldom seen and they avoid rather than approach man. At Wahoo Lake on July 4, 1952, a large bear, estimated at 600 pounds, was hunting for small mammals on a broad slope leading down to a lake. The bear was walking up wind directly toward our camp of three large white tents that were plainly visible at all times. The personnel of our party were talking and moving back and forth from one tent to the other. The bear approached to within 23 meters of camp, for the first time looked in our direction, showed some concern by testing the air for odors, continued forward for a meter in its hunting, stopped, stood on its hind feet, sniffed the air for several seconds, and looked in our direction. After several loud shouts from members of our party the bear reversed its course and ran back to the mouth of the canyon from where it had originally emerged onto the floor of the valley. This incident suggests that the grizzly fears anything that is outside of its own experience and secondly that it depends more on smell than on sight as a guide. The bear seems not to see well. Reports of bears charging may result from confusion on the bears' part. Eskimos intentionally get the attention of a bear before shooting at it. The idea is that the bear, if only wounded, will not run over the hunter. However, these bears have been reported to defend their young. Otherwise, on the Arctic Slope, at least, this bear seems not be be aggressive toward man.

At Porcupine Lake on July 17, 1952, a bear was alternately digging and resting as it excavated roots from the edge of a creek. A second bear was approaching through the willows of the same creek. At about 30 meters the second bear stopped and stood on its hind legs and sniffed the air. Not satisfied with the odor alone, the bear gained a position seven meters higher on the sidehill where it again stood upright and tested the air. It returned to the creek and then to the sidehill from where it again attempted to see or smell whatever was ahead. At one time the first bear moved about 5 meters in the general direction of the second bear but immediately returned to its digging. The second bear loitered around the area for approximately 45 minutes, and after walking out around the first bear continued on up the canyon. The above-described behavior suggests that these bears do not have definite hunting territories which they defend from other bears.

In summer, grizzly bears are active at any hour of the day or night but more so in the day. As is the case with many other kinds of mammals on the Arctic Slope, activity is influenced more by temperature and overcast conditions than by the period of the day or night.

Most of the non-feeding hours are spent on temporary resting beds on sidehills or among willows and shrubs in valleys. According to Pete Sovalik:

> Most of the grizzly bears that live on the Coastal Plain in summer move in late autumn and early winter onto the Plateau Province or into the high Brooks Range where they excavate dens. The bears go into these winter dens about the last of October and emerge on or before May 1. Most of the grizzly bears den, but some of the medium sized bears and a few of the exceptionally large bears remain active throughout the year, especially in the mountains where open water of the fast moving streams permit them to fish in the winter.
>
> The bears which do not den, improvise beds, lined with leaves, grasses and miscellaneous trash, among willows and below the surface of the snow but without overhead protection.

Rausch (1951:170) reports an instance of parturition in the grizzly bear in December and reports tracks of an old female, cubs and a yearling traveling together on April 3, 1950, at Anaktuvuk Pass. In July we have observed adult females with one, two and three cubs. The testes of a two year old (51563) measured 50 × 30 × 20 millimeters and the baculum of this same specimen was 115 millimeters long.

Harmon Helmericks told us that although some grizzly bears are almost black, all have a brownish hump. Pete Sovalik stated that:

> Upon leaving their dens about May 1, the grizzly bears are nearly black but that after contact with the air and sunlight the hair turns brown without molting; in the later part of summer, there is a molt from old hair to new hair; after denning the hair is colored like the pelage of the marmot of the Brooks Range; the legs and underparts usually are wet and discolored by mud and soil especially when the grizzly bears have been traversing wet terrain, which, on the Arctic Slope, is the usual condition.

The hind foot of a two year old male (51563) measured (including claws) 220 millimeters long; the claw on the third digit measured 18 millimeters on the ventral side; the front foot was 140 millimeters long and 127 millimeters wide; the claw of the third digit was 44 millimeters long on the ventral side; the pad of the third digit of the front foot measured 26 millimeters long and 41 millimeters wide. Of several other grizzly bears, of unknown sex and age, from the Lake Schrader-Lake Peters area tracks of hind feet measured 260 × 150, 260 × 150, 250 × 150; tracks of forefeet measured 190 × 158, 190 ×148, 150 × 130.

Records of occurrence.—Specimens examined, 4: Nos. 50979, 51562, 51563 and 51980 skulls only. These are distributed by localities as follows: (51) Driftwood, Utukok River, 161°12′10″, 68°53′47″, 1200 ft., 1; (58) convergence of Chandler River and Sic-sic-puk River, approximately 1800 ft., 1; (70) Chandler Lake, 152°45′, 68°12′, 2900 ft., 2.

Additional records: (1) Alaktah River near Admiralty Bay (Rausch, 1951: 165); (2) Teshekpuk Lake, 153°58′00″, 70°40′30″ (seen by Harmon Helmericks in July 1948—*fide* J. W. Bee, MS, 8 September 1952); (3) ? Meade River [where on river unspecified] (Nelson and True *in* Nelson, 1887:233; Murdock *in* Ray, 1885:94); (4) back of Wainwright [definite locality not specified] (Bailey and Hendee, 1926:13); (5) Chipp River, 155°18′00″, 70°24′30″ (seen by Harmon Helmericks in July 1948—*fide* J. W. Bee, MS, 8 September 1952); (6) mouth Colville River, 151°05′00″, 70°21′30″ (seen by H. Helmericks in September 1951—*fide* J. W. Bee, MS, 8 September 1952; (7) Sagavanirktok River, 148°24′00″, 70°12′30″ (seen by Wood, an Eskimo, in 1944—*fide* J. W. Bee, MS, 8 September 1952); (8) 6 mi. up Avalik River, 159°16′, 70°06′ (tracks noted by Atanak, an Eskimo from Wainwright, on 12 July 1952—*fide* J. W. Bee, MS, 17 July 1951); (9) back of Icy Cape (Bailey and Hendee, 1926:13); (10) 7 mi. up Kaolak River from junction of the Avalik and Kolik rivers, 159°50′00″, 70°02′10″ (bear killed by Atanak of Wainwright in 1950—*fide* J. W. Bee, MS, 17 July 1951; (11) barren grounds of northwestern Alaska [no definite locality specified] (True, 1884:608); (12) Kaolak River, about 50 mi. SE Wainwright (Rausch, 1951:165); (13) Utukok River, about 90 mi. SW Wainwright (Rausch, 1951:165); (14) Sadlerochit River, 144°21′, 69°52′ (seen by Charles W. Whittington on 30 August 1948 —*fide* J. W. Bee, MS, 8 September 1952); (15) Oumalik (Rausch, 1951:165); (16) Meade River, 157°33′00″, 69°39′15″ (seen by Pete Sovalik on November 15, 1938—*fide* J. W. Bee, MS, 8 September 1952); (17) Ikpikpuk River, 154°57′, 69°39′ (seen by Charles W. Whittington on June 1, 1947—*fide*

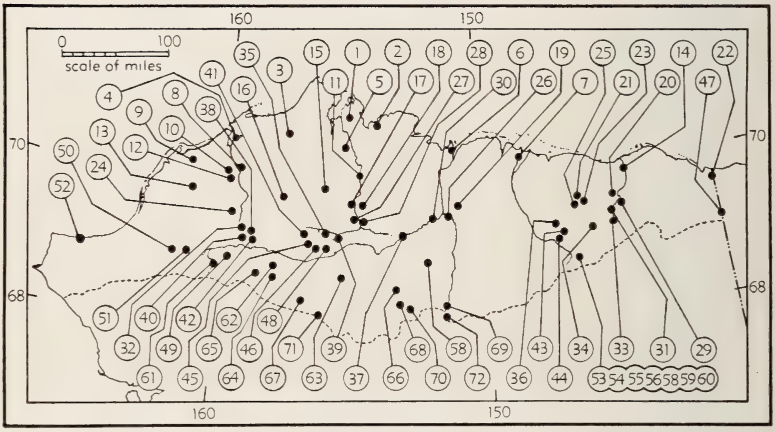


FIG. 86. Record stations of occurrence for *Ursus horribilis richardsoni.*

J. W. Bee, MS, 8 September 1952); (18) Wolf Creek Camp, 154°32′, 69°38′ (seen by William L. Wyatte on June 8, 1952–*fide* J. W. Bee, MS, 28 June 1952); (19) Itkillik River, 150°48′, 69°35′ (seen by Joash Tukle in 1935–*fide* J. W. Bee, MS, 8 September 1952); (20) Sadlerochit River, 144°51′00″, 69°32′20″ (seen by Charles W. Whittington on August 3, 1948–*fide* J. W. Bee, MS, 8 September 1952); (21) 5 mi. W Shublik Springs in the valley of the Canning River (Rausch, 1950c:465; 1951:165); (22) within few miles of Arctic Coast near international boundary (Dufresne, 1946:57); (23) Canning River, 146°00′, 69°32′ (seen by Marvin Mangus on August 12, 1947–*fide* J. W. Bee, MS, 8 September 1952); (24) Ketik River, 159°31′00″, 69°30′20″ (a female and two cubs seen by Charles W. Whittington on July 1, 1952–*fide* J. W. Bee, MS, 8 September 1952); (25) Canning River, 146°20′, 69°29′ (seen by Marvin Mangus on August 12, 1947–*fide* J. W. Bee, MS, 8 September 1952); (26) Anaktuvuk River, 151°09′, 69°28′ (seen by Harmon Helmericks on May 10, 1952–*fide* J. W. Bee, MS, 8 September 1952); (27) Valley of Willows, 154°53′00″, 69°27′30″ (2 adults seen by Marvin Mangus on April 25, 1948–*fide* J. W. Bee, MS, 8 September 1952); (28) Titaluk, approximately 6 mi. E Ikpikpuk at Valley of the Willows, 154°32′, 69°26′ (seen by Max Brewer on July 15 and 17, 1951–*fide* J. W. Bee, MS, 5 September 1952); (29) Hulahula River, 144°39′00″, 69°22′30″ (seen by Charles W. Whittington on June 28, 1948–*fide* J. W. Bee, MS, 8 September 1952; Anderson *in* Stefansson, 1913b:520 [definite locality not specified]); (30) top of a bluff along the Colville River near Umiat (Rausch, 1951:165); (31) Lake Peters, 145°10′00″, 69°21′36″, 2930 ft. (seen by Charles W. Whittington on July 15, 1948–*fide* J. W. Bee, MS, 8 September 1952); (32) Carbon Creek, 158°59′00″, 69°15′32″ (two adults seen by Charles W. Whittington on July 2, 1949–*fide* J. W. Bee, MS, 8 September 1952); (33) Lake James Robert, Romanzof Mountains, 145° 10′00″, 69°16′30″ (tracks noted by J. W. Bee on August 8, 1952); (34) Canning River, 145°54′00″, 69°14′30″ (seen by Marvin Mangus on July 15, 1947–*fide* J. W. Bee, MS, 8 September 1952); (35) Kigalik Creek, 155°53′00″, 69°14′28″ (seen by Charles W. Whittington in 1947–*fide* J. W. Bee, MS, 8 September 1952); (36) Ivashak River, 147°15′, 69°14′ (seen by Marvin Mangus on April 20, 1952–*fide* J. W. Bee, MS, 8 September 1952); (37) Colville River, 153°08′, 69°13′ (Thomas Cade reported cache destroyed between June 25 and August 13, 1952–*fide* J .W. Bee, MS, 8 September 1952); (38) Carbon Creek, 158°11′00″, 69°12′34″ (seen by Charles W. Whittington on June 10, 1949–*fide* J.W. Bee, MS, 8 September 1952); (39) Kigalik Creek, 155°22′00″, 69°10′35″ (seen by Charles W. Whittington in 1947–*fide* J. W. Bee, MS, 8 September 1952); (40) Carbon Creek, 158°25′00″, 69°10′30″ (two adults seen by Charles W. Whittington on July 1, 1949–*fide* J. W. Bee, MS, 8 September 1952); (41) Awuna River, 156°09′, 69°10′ (three adults seen by Charles W. Whittington on July 5, 1952–*fide* J. W. Bee, MS, 8 September 1952); (42) Carbon Creek, 158°10′00″, 69°08′30″ (two adults seen by Charles W. Whittington on July 5, 1949–*fide* J. W. Bee, MS, 8 September 1952); (43) Ivashak River, 146°50′00″, 69°08′20″ (seen by J. W. Bee on July 3, 1952); (44) Wahoo Lake, 146°58′, 69°08′, 2350 ft. (seen by J. W. Bee on July 4, 1952); (45) Awuna River, 156°28′, 69°04′ (seen by Charles W. Whittington on July 7, 1951–*fide* J. W. Bee, MS, 8 Sept. 1952); (46) Awuna River, 156° 22′00″, 69°03′50″ (seen by Charles W. Whittington on July 7, 1951–*fide* J. W. Bee, MS, 8 September 1952); (47) Alaska-Yukon boundary, about 50 miles south of Arctic Coast (lat. 69°00′30″) (Merriam, 1918:103; Miller, 1924:103); (48) Awuna River, 155°54′00″, 69°00′10″ (seen by Charles W. Whittington on May 25, 1947, and later in the same summer–*fide* J. W. Bee, MS, 8 September 1952); (49) headwaters Colville River [dot on map at center of area concerned] (seen by Charles Hummel in June, July and August of 1950–*fide* J. W. Bee, MS, 11 June, 1952); (50) between the upper Utukok River and west fork of Koblik River, center of area approximately 161°40′, 68°59′ (approximately 30 individuals seen by Marvin Mangus from May 30 to September 1, 1950–*fide* J. W. Bee, MS, 8 September 1952); (52) Corwin Bluff (Brower, 1942:17); (53) Canning River, 146°19′45″, 68°53′30″ (seen by

J. W. Bee on July 18, 1952); (54) Porcupine Lake, 146°29′30″, 68°51′55″ (seen by J. W. Bee on July 12, 1952); (55) Ivashak River, 146°37′00″, 68°51′23″ (seen by William P. Brosge on July 15, 1952—*fide* J. W. Bee, MS, same date); (56) left fork Annette Creek, 146°26′40″, 68°51′18″ (seen by J. W. Bee on July 17, 1952); (57) left fork Annette Creek, 146°26′43″, 68°51′ 10″ (seen by J. W. Bee on July 17, 1952); (59) Canning River, 146°21′55″, 68°50′47″ (seen by J. W. Bee on July 17, 1952); (60) Ivashak River, 146°34′00″, 68°50′10″ (seen by J. W. Bee on July 17, 1952); (61) Lake Noluk, 159°58′00″, 68°49′20″ (killed by Speckman in August 1950 and reported by Marvin Mangus—*fide* J. W. Bee, MS, 8 September 1952); (62) Kuna River, 157°46′00″, 68°48′30″ (seen by Marvin Mangus on April 14, 1949—*fide* J. W. Bee, MS, 8 September 1952); (63) Etivluk River, 155°58′00″, 68°47′50″ (a female and two cubs seen by Frank Cernick in July 1951—*fide* J. W. Bee, MS, 8 September 1952); (64) Kuna River, 157°51′00″, 68°38′35″ (seen by Marvin Mangus on July 4, 1949—*fide* J. W. Bee, MS, 8 September 1952); (65) Kiligwa, 158°25′00″, 68°38′15″ (seen by Frank Cernick in August 1951—*fide* J. W. Bee, MS, 8 September 1952); (66) north side of the Endicott Mountains [definite locality not specified] (Anderson *in* Stefansson, 1913b:519); (67) Etivluk River, 156°45′00″, 68°21′10″ (two adults, one of which was 96 inches long, seen by Marvin Mangus on May 30, 1949—*fide* J. W. Bee, MS, 8 September 1952); (68) Okominilaga Cr. (Rausch, 1953: 101); (69) Tolugak [Tulugak] Lake (Rausch, 1950c:465; 1951:168); (71) within 3 miles of Itivlik Lake and northwesterly along the Aklasuruk River for approximately 8 miles (tracks and sign, seen by Irving and Paneak, 1954: 204); (72)Anaktiktoak Creek (Rausch, 1951:168).

Ursus americanus americanus Pallas

Black Bear (Igagrik)

Ursus americanus Pallas, . . . Spicilegia zoologica, . . . fasc. 14, p. 5, 1780, from eastern North America.

Description.—Medium-sized bear differing from the grizzly as follows: weight approximately one-third less; no hump in shoulder region; claws on forefeet not notably longer than those on hind feet; claw of second digit of forefoot ordinarily less, instead of more, than 52 mm (approximately 2¹⁄₁₆ inches) long; pelage black or cinnamon-brown; front of skull relatively straight instead of dish-faced in lateral profile; last upper molar small (see fig. 87).

Remarks.—Material of the black bear from the Arctic Slope never has been saved for study and we use, tentatively, the name *U. a. americanus.*

Harry S. Newman, who had been at several camps on the Plateau and Coastal Plain and who had also trapped fur-bearers for several winters in southeastern Alaska, told us that he had never seen a black bear north of the crest of the Brooks Range but had heard reports of this bear occurring on the north slope of the Range. Rausch (1951:171) has a specimen killed near the mouth of Inukpasukruk Creek at the head of the John River. This locality is approximately three miles south of the southern boundary of the area we define as the Arctic Slope.

Records of occurrence.—Specimens examined, none.

Additional records: (1) Carnivore Lakes, 145°10′00″, 69°17′25″, 3385 ft. (tracks having short claw-marks noted by James W. Bee on August 8, 1952); (2) Kukpowruk River, 163°, 69° (killed by Jacob A. Stalker, an Eskimo from Noatak, in 1937—*fide* J. W. Bee, MS, 8 September 1952); (3) Cape Thompson, 166°02′, 68°15′ (killed by Jacob A. Stalker in 1936—*fide* J. W. Bee, MS, 8 September 1952).

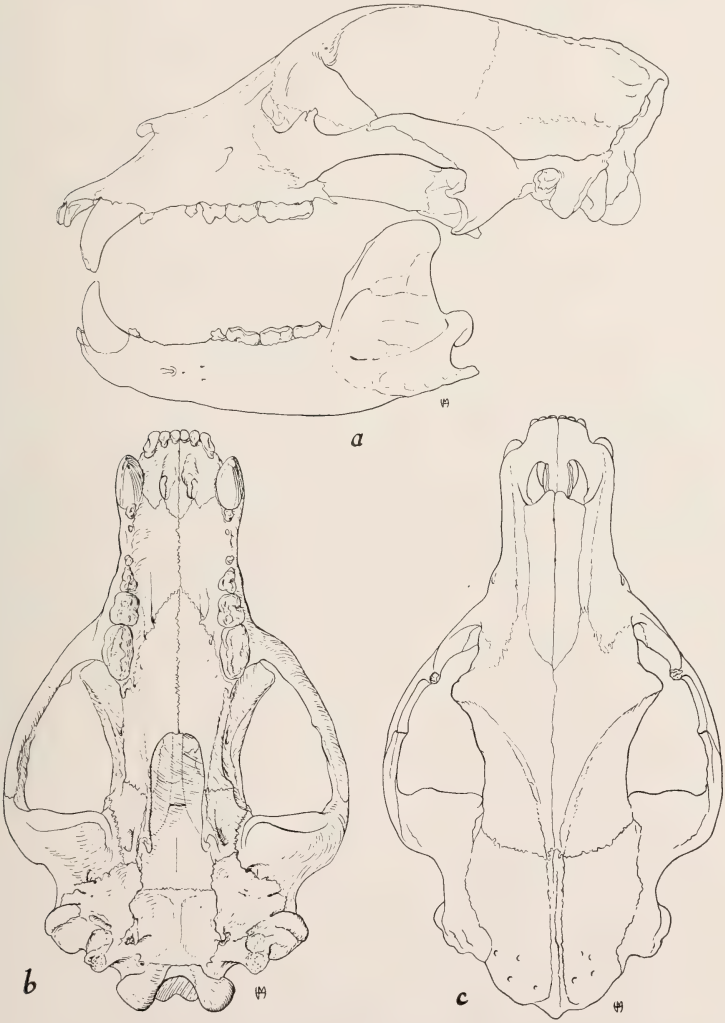


Fig. 87. Skull of *Ursus americanus* [subspecies *californiensis* J. Miller], 6 mi. N Weldon, Kern Co., California, No. 16269 MVZ, ♂. × ¼.

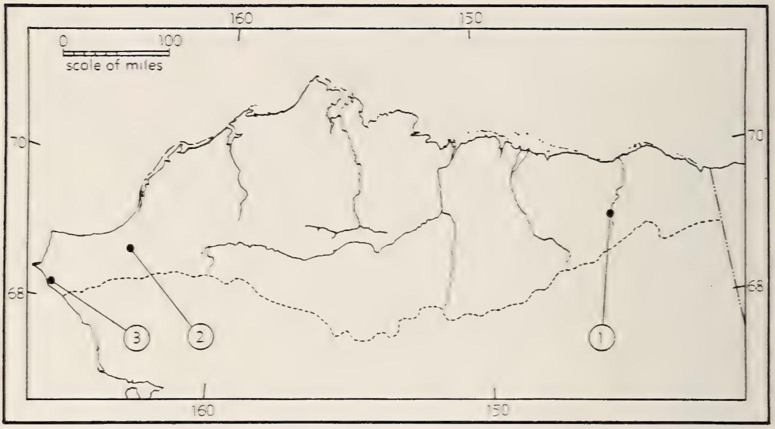


FIG. 88. Record stations of occurrence for *Ursus americanus americanus.*

Thalarctos maritimus maritimus (Phipps)

Polar Bear (Nanuk)

Ursus maritimus Phipps, Voyage toward the North Pole, . . . p. 185, 1774, type from Spitsbergen. (Also Harlan, 1825:51; Murdock *in* Ray, 1885:94; Anderson, 1937:105.)

Thalassarctos maritimus, True, Proc. U. S. Nat. Mus., 7 (App., Cir., 29) :608, November 29, 1884. (Also Nelson and True *in* Nelson, 1887:233, 254; Elliot, 1901:310.)

Thalarctos maritimus, W. Stone, Proc. Acad. Nat. Sci. Philadelphia, 52:44, March 24, 1900. (Also Anderson *in* Stefansson, 1913b:522; Bailey and Hendee, 1926:13.)

Thalarctos maritimus maritimus, Anthony, Field book of North American Mammals, G. P. Putnam's Sons, p. 86, 1928 (5th impression).

Description.—Large (up to 8 feet long), long-necked, small-headed, white bear with relatively small cheek-teeth and relatively long canine teeth (see cover illustration and fig. 89).

The polar bear is more typically a marine mammal than a land mammal and is a member of a distinct community of birds and animals which live on the ice packs in the Arctic Ocean. During winter, or whenever the polar ice drifts to or near to the coast line, some of the polar bears go on shore and occasionally one goes inland. In the winter and spring of 1952 (prior to June 17) Eskimos had shot 8 polar bears from the ice pack north of Barrow Village. Two of these were an adult male and female shot together ¼ of a mile north of Point Barrow at the time the pack ice contacted the shore-ice. There were two cubs, with these adults, which refused to leave the mother. When forcibly separated from her they were restless until allowed to lie on her pelt. The cubs were brought to Barrow Village where they remained with the hide of the female. Brown lemmings were fed to these cubs. After a week one cub escaped. These cubs were captured on June 16, 1952, and were estimated to be 700 mm in length and 320 mm in height.

On August 16, 1951, while on an ice cutter in the Arctic Ocean, Ira L. Wiggins saw a female and two cubs swimming together

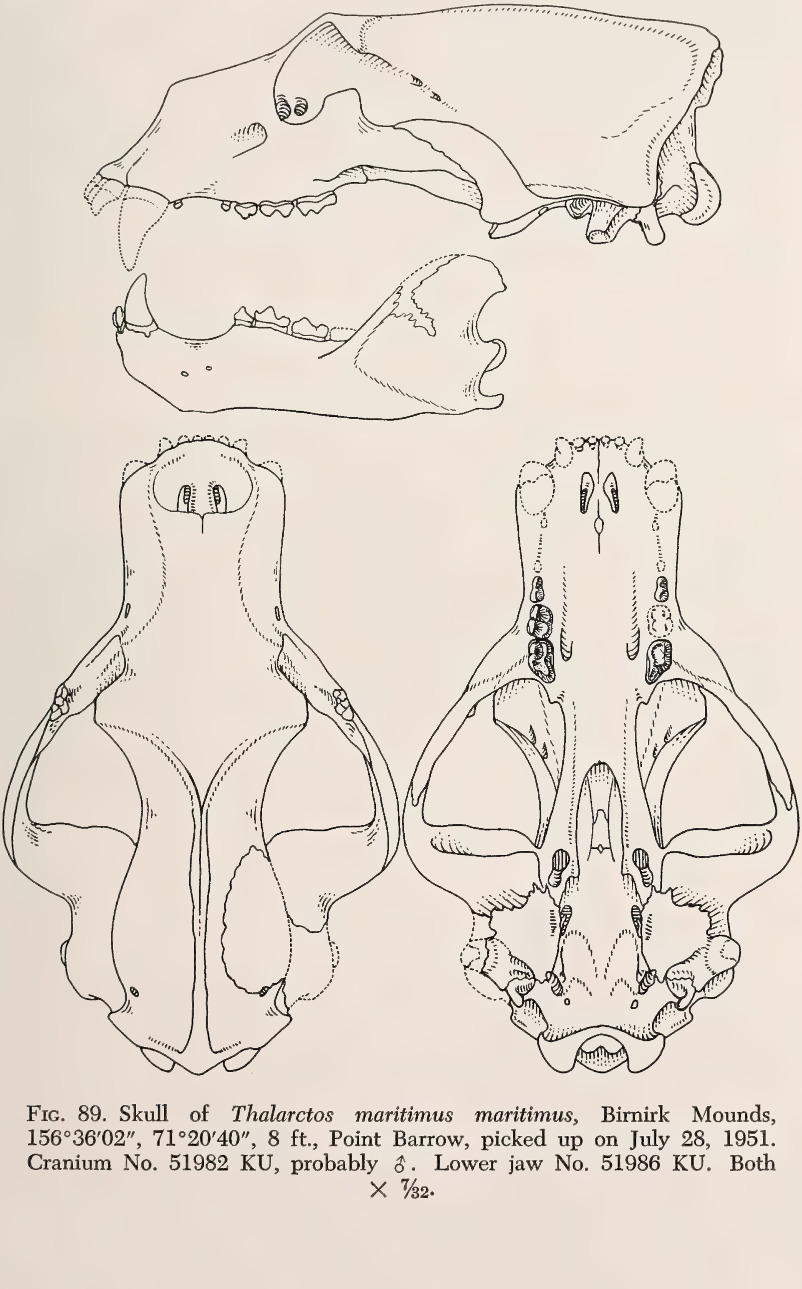


Fig. 89. Skull of *Thalarctos maritimus maritimus,* Birnirk Mounds, 156°36′02″, 71°20′40″, 8 ft., Point Barrow, picked up on July 28, 1951. Cranium No. 51982 KU, probably ♂. Lower jaw No. 51986 KU. Both × 7/32.

approximately 35 miles northwest of Barrow Village and at least 50 miles from the nearest ice flow to the north. Each of the young as measured from photographs taken of these bears while they were swimming alongside the ship, was 65 per cent as long as the adult.

Harmon Helmericks told us that George Wood, an Eskimo, killed a male polar bear on the Sagavanirktok River near the foothills of the Brooks Range in September of 1944. This bear was reported as being in good condition and very fat.

Wilbert K. Carter excavated several polar bear skulls from House Q at Birnirk Mounds. The measurements of the largest skull are: Back of incisor tooth to foramen magnum, 347; greatest length of skull, 460; zygomatic breadth, 263; interorbital width, 107; anterior edge of first incisor to posterior edge of second molar, 148; width of rostrum across canine teeth, 100; width of tooth-rows across second upper molars, 94; width of palate between second upper molars, 60; length of exposed part of upper canine, 56. Each of two other skulls measured 200 mm in zygomatic breadth.

Polar bears are killed each year by Eskimos at Barrow Village and skulls and other bones were present in relatively large numbers in Birnirk Mounds. The polar bear seems to have been common and useful to the Eskimo at Point Barrow, especially in the early days before the white man was there. Up until that time at least, the brains of the polar bears were eaten and were extracted through a hole, approximately 90 × 70 millimeters, chiseled in the side of the braincase.

Records of occurrence.—Specimens examined, 2; Nos. 51982 skull only and 51986 mandible only, from (2) Birnirk Mounds, 156°36′02″, 71°20′40″, 8 ft., Point Barrow.

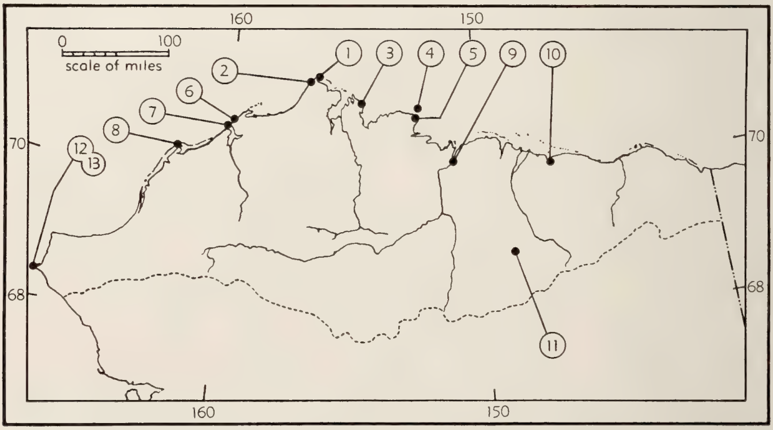


Fig. 90. Record stations of occurrence for *Thalarctos maritimus maritimus.*

Additional records: (1) Point Barrow (Murdock *in* Ray, 1885:94; Nelson and True *in* Nelson, 1887:233; W. Stone, 1900:44; Leffingwell, 1919:66; Bailey and Hendee, 1926:13; Brower, 1942:247); west of Point Barrow (Anderson, 1937:105); (3) [definite localities not specified]: most northern coasts of America (Harlan, 1825:53); northern America (True, 1884:608); Arctic Ocean (Dufresne, 1946:65); Arctic regions (Elliot, 1901:310); Arctic Coast of Alaska (Anthony, 1928:86); [Arctic Slope] (Burt and Grossenheider, 1952:33); (4) 8 mi. N Pitt Point, 152°22′, 70°58′ (killed by Harmon Helmericks in winter of 1952—*fide* J. W. Bee, MS, 8 Sept. 1952); (5) Pitt Point (Bailey and Hendee, 1926:14); (6) a few miles north of Wainwright (Bailey and Hendee, 1926:14); (7) Wainwright (Bailey and Hendee, 1926:13); (8) Icy Cape (Bailey and Hendee, 1926:13); (9) mouth Colville River, 151°00′00″, 70°39′30″ (female and two cubs seen by Harmon Helmericks in 1949—*fide* J. W. Bee, MS, 8 September 1952); (10) near mouth of Shaviovik River, west of Flaxman Island (Anderson *in* Stefansson, 1913b:522; Anderson, 1943: 522); (11) West Fork Sagavanirktok River, 148°51′00″, 68°55′30″ (a fat female killed by George Wood, an Eskimo, in September 1944—*fide* J. W. Bee, MS, 8 September 1952); (12) Point Hope (Nelson and True *in* Nelson, 1887: 255; Bailey and Hendee, 1926:13); (13) 6 mi S Tigara [= Point Hope] (Brower, 1942:64).

Mustela erminea arctica (Merriam)
Ermine (Itigiak)

Putorius arcticus Merriam, N. Amer. Fauna, 11:15, June 30, 1896, type from Point Barrow, Alaska. (Also W. Stone, 1900:44; Elliot, 1901:345.)

Putorius erminea, True, Proc. U. S. Nat. Mus., 7(App., Cir. 29):609, November 29, 1884. (Also Murdock *in* Ray, 1885:94; Turner, 1886:208; Nelson and True *in* Nelson, 1887:233.)

Putorius richardsoni, Bangs, Proc. Biol. Soc. Washington, 10:16; February 25, 1896.

Mustela arcticus, Anderson *in* My life with the Eskimo by V. Stefansson, The Macmillan Co., New York, p. 523, 1913.

Mustela arctica, Hall, Univ. California Publ. Zool., 30:420, March 19, 1929.

Mustela erminea arctica, Ognev. The mammals of U.S.S.R. and adjacent countries, 3:31, 1935. (Also Hall, 1944:599; 1945:179; Rausch, 1950c:465; Hall, 1951:96; Rausch, 1951:175; 1953:113.)

Mustela arctica arctica, Miller, U. S. Nat. Mus. Bull., 79:97, 1912. (Also Bailey and Hendee, 1926:15; Anderson, 1937:106; Dixon, 1938:149.)

Mustela erminea, Burt and Grossenheider, A field guide to the mammals, Houghton Mifflin Co., Boston, p. 39, 1952.

Description.—Larger (10 to 14 inches long) of two weasels on the Arctic Slope; tail more than 2 inches long, always black on approximately distal half; upper parts brown in summer and white in winter; underparts always broadly white or yellowish white.

Measurements of 1 adult male (43155) from Anaktuvuk Pass, 1 adult male (51554) from Mount Mary and 1 adult female (43852) from Chandler Lake are, respectively, as follows: Total length, ♂ 354, ♂ 314, ♀ 286; tail, 94, 85, 76; hind foot, 53, 46, 40; ear from notch, 22, 21, 20; weight, ———, 152, 114 gms.; basilar length (of Hensel), 45.2, 43.2, 35.6; length of tooth-rows (this and other cranial measurements taken as described by Hall, 1951:417), 16.6, 15.2, 13.0; mastoid breadth, 23.4, 22.5, 18.7; zygomatic breadth, 28.8, 26.8, 21.7 (in each instance more than 61 (61.1-66.0) per cent of basilar length); volume of braincase (weight in grams of No. 12 shot), 28.9, 25.7, 19.4. Winter pelage white except black tip of tail. Adult male (43115) trapped in October of 1950 in winter pelage has a suffusion of Massicot Yellow on venter of body, legs, feet and tail. Summer pelage of young male (43851) with upper parts Raw Umber; underparts, inside of forelegs, medial sides of hind legs to near ankle, Barium Yellow; basal two-fifths of ventral side of tail near (17″*h*) Tawny Olive; rims of ears white. Summer pelage of adult male (51556) with upper parts Dresden Brown; underparts, inside of forelegs, medial sides of hind legs to near ankle, Napthalene Yellow; basal two-fifths of ventral side of tail like belly. Extremes of underparts of adults from Marguerite Yellow (♂ 51554) to Amber Yellow (♀ 43852). Notable features are body long, legs short, head small, tail approximately two-fifths total length, males one-fifth to one-fourth longer than females, musk glands well developed, skull with large braincase and short precranial portion, 34 teeth, bullae long and relatively flat, sexes colored alike, upper parts brown in summer and sharply contrasting with white or cream or yellow underparts. In winter, white except tip of tail which is black, yellow tinge usually present on lower back and underparts, soles densely haired.

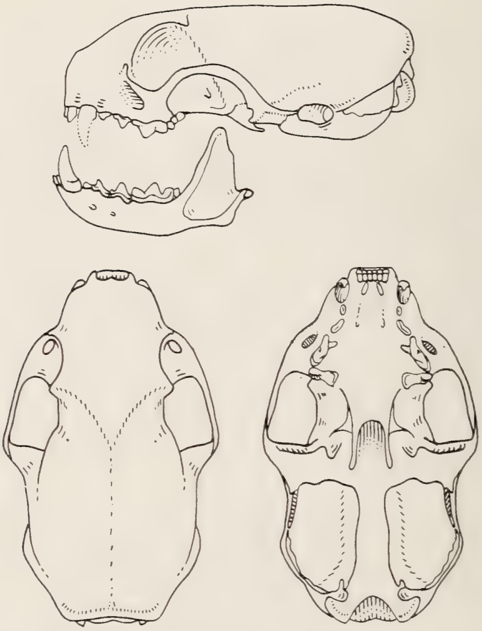


FIG. 91. Skull of *Mustela erminea arctica,* SE end Lake Peters, 145°09′26″, 69°20′50″, 2950 ft., Romanzof Mts., August 9, 1952, No. 51551 KU, ♂. × 1.

Remarks.—The large, tear-drop shaped, braincase of adult ermine from the Arctic Slope, in contrast to the small elongate oval braincase of adult ermine from the Transcontinental Coniferous Forests and temperate regions, is probably a function of the increased size of animals on the Arctic Slope.

The ermine is common throughout the Arctic Slope, especially in the Brooks Range and along major rivers of the Plateau Province, and lives mainly in areas where there is relief such as on slopes of mountains and hills, in and around rockslides, and along banks of streams and shores of lakes. It seldom is seen or trapped in damp and wet meadows of grasses and sedges. On the Arctic Slope the ermine is the ecological equivalent of the long-tailed weasel in the western United States.

In 1951 Atanak, an Eskimo from Wainwright, said that ermine had been numerous at Anaktuk along the Kuk River a few years before but that they had disappeared from the area. In the summer of 1950, at the headwaters of the Colville River, Charles Hummel, of the U. S. Geological Survey, saw six individuals, probably a family group, traveling together. On four occasions at Lake Peters on August 4, 1952, ermine were observed crossing rockslides, but seemed not to be systematically searching the rockslides. On July 15, 1952, at Porcupine Lake, an ermine ran 90 meters along the shore line within one-third of a meter from the edge of the lake, hurriedly searching all irregularities of the shore line, as if attempting to surprise its prey, and finally jumped up on top of the meter-high bank. Near the south end of Chandler Lake on August 25, 1951, Daniel Livingston and Kirk Bryon, while floating down a river

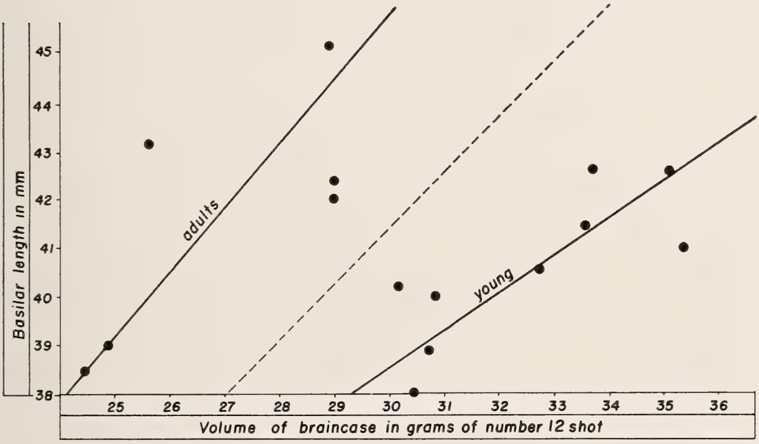


FIG. 92. Volume of the braincase in six adult and nine young males of *Mustela erminea arctica,* trapped in August in 1951 and 1952, from Chandler Lake and Mount Mary, Alaska. The volume of the braincase is approximately 20 per cent more in the young than in the adults.

in a boat observed an ermine on the bank following them. At times the ermine ran back and forth in a nervous and excited manner and barked continually. After trailing the boat for more than 30 meters, the ermine turned back. On August 12, 1951, at Chandler Lake, ermine were active both by day and by night. At late twilight, one ran along the edge of a rockslide, jumping from rock to rock and stopping occasionally to survey the rock field.

At Weasel Point, at the south end of Lake Peters, a single steel trap was set at the base of a fissure which led up to the top of an overhanging ledge. Animals traveling up the canyon were forced either to ford the stream, which flowed against an almost vertical ledge, or to ascend the ledge by way of the fissure. Four adult males and one young female were taken from this single trap in the period August 9-16, 1952. Most of these weasels were caught at night. The hind part of the body and one front leg of the female had been pulled from the trap by another weasel and carried three meters away on the sands at the edge of the creek. The side of the chest and abdomen had been eaten but the lungs, liver, heart and stomach were left. The head and neck and the other front leg remained in the trap. At Wahoo Lake, on July 10, 1952, an ermine was taken from a trap set in a caribou trail.

There were lesions in the bone covering the frontal sinuses in two of the six adult ermine which we examined from the Arctic Slope. None of the 10 younger animals showed damage to the bone.

Records of occurrence.—Specimens examined, 17: Nos. 43155, 43850-43856, 51548-51552, 51554, 51556, 51557; skull only, 51555. These are distributed by localities as follows: (10) SE end Lake Peters, 145°09′26″, 69°20′56″,

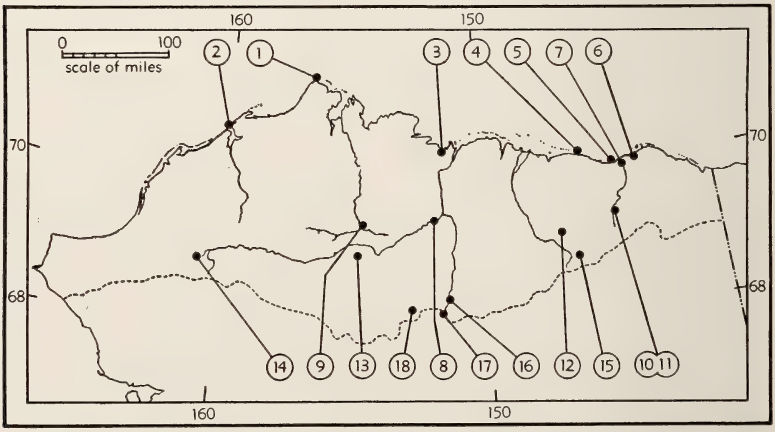


Fig. 93. Record stations of occurrence for *Mustela erminea arctica.*

2950 ft., Brooks Range, 4; (11) Mount Mary, S end Lake Peters, 145°10′02″, 69°20′30″, 2920 ft., Brooks Range, 4; (12) Wahoo Lake, 146°58′, 69°08′, 2350 ft., Brooks Range, 1; (17) Chandler Lake, 152°45′, 68°12′, 2900 ft., 7; (18) Anaktuvuk Pass, 1 (see also Rausch, 1951:175; 1953:113).

Additional records: (1) Point Barrow (Murdock *in* Ray, 1885:94; Nelson and True *in* Nelson, 1887:233; Merriam, 1896:15; W. Stone, 1900:44; Elliot, 1901:345; Miller, 1912b:97; 1924:119; Bailey and Hendee, 1926:15; Anthony, 1928:102; Hall, 1929:420; Anderson, 1937:106; Hall, 1945:179; 1951:102); (2) Wainwright (Bailey and Hendee, 1926:15); (3) Fish Creek Camp, 151°30′, 70°18′ (seen by Harry S. Newman in summer of 1949—*fide* J. W. Bee, MS, 25 July 1951); (4) Flaxman Island (Hall, 1951:102); (5) Collinson Point (Hall, 1951:102); (6) Hulahula River (Hall, 1951:102); (7) Salirochet [Sadlerochit] River (Hall, 1951:102); (8) Umiat (Rausch, 1950c:465); (9) Titaluk, 154°32′, 69°26′ (six animals seen by Harry S. Newman—*fide* J. W. Bee, MS, 25 July 1951); (13) [definite localities unspecified]: The Arctic Coast (True, 1884:609); all the mainland of Alaska (Turner, 1886:208); all of Alaskan mainland (Nelson and True *in* Nelson, 1887:245); Arctic America (Trouessart, 1904-05:209); Arctic Coast [of Alaska] (Anderson *in* Stefansson, 1913b:523); along the Arctic Coast (Dixon, 1938:150); [Arctic Slope] (Burt and Grossenheider, 1952:38); (14) head Colville River (seen by Charles Hummel, June, July, 1950—*fide* J. W. Bee, MS, 11 June 1952); (15) Porcupine Lake, 146°29′15″, 68°52′28″, 3140 ft., (seen by J. W. Bee, 15 July 1952); (16) Tolugak [Tulugak] Lake (Rausch, 1950c:465).

Mustela rixosa eskimo (Stone)
Least Weasel (Naulayuk)

Putorius rixosus eskimo W. Stone, Proc. Acad. Nat. Sci. Philadelphia, 52:44, March 24, 1900, type from Point Barrow, Alaska. (Also Elliot, 1901:345.)

Mustela rixosa eskimo, Miller, Bull. U. S. Nat. Mus., 79:96, December 31, 1912. (Also Hall, 1929:421; Dufresne, 1946:111; Hall, 1951:181.)

Mustela rixosa rixosa, Anderson, Mammals and birds of the Western Arctic District, Northwest Territories, Canada; reprinted from Canada's Western Northland, Ottawa, p. 106, 1937. (Also Rausch, 1950c:465.)

Description.—Smaller (less than 9½ inches long) of the two weasels on the Arctic Slope; tail less than 2 inches long and hair at tip ordinarily including a few that are black; upper parts brown in summer and white in winter; underparts always broadly white.

Measurements of a young female (43858) from Umiat are: Total length, 160; tail, 23; hind foot, 20; ear from notch, 10; weight, 33 gms.; basilar length (of Hensel), 25.9; length of tooth-rows, 8.8; mastoid breadth, 9.9; zygomatic breadth, 13.2; volume of braincase (weight in grams of No. 12 shot), 8.8. Winter pelage white; summer pelage of a young female (43858) with upper parts near (11′*n*) Chestnut Brown and sharply contrasting with white underparts; white of underparts extending over upper lips, inside of limbs and on feet; tail same color as upper parts. Smallest carnivore on the Arctic Slope; long body; short legs; small head; tail approximately 15 per cent of total length; males larger than females; skull with large braincase and short precranial portion; 34 teeth; tympanic bullae long and flat; soles of feet densely haired.

The least weasel occurs over all of the Arctic Slope and according to Clay Kaigelak, a 35 year old Eskimo, was common in the foothills (Plateau Province) but uncommon in the lowlands except during, and immediately after, a high in the lemming population.

On September 3, 1951, at Umiat, a least weasel was trapped in a community supporting grasses, sedges and the tundra vole. The point of capture was more than 200 meters from other kinds of communities on the sides of the valley. This weasel was trapped from a runway of the tundra vole on a fracture ridge which was 100 millimeters above the wet soils and sedges of the marsh. This runway was partly protected by dwarf willows approximately 350 millimeters high. On September 2, in the line of traps where the least weasel was caught, many traps were sprung possibly by the weasel.

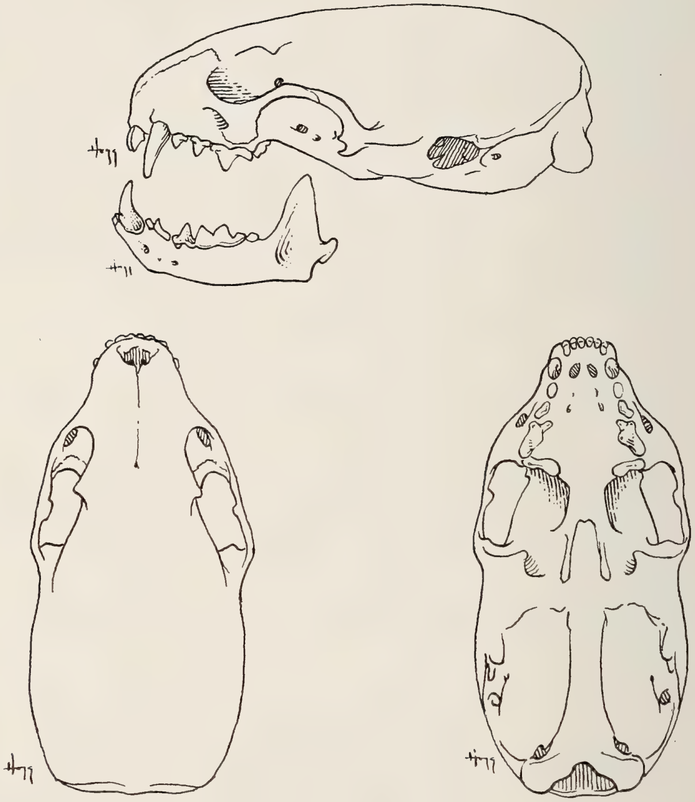


Fig. 94. Skull of *Mustela rixosa* [subspecies *rixosa* (Bangs)], Jadis, Roseau Co., Minnesota, December 28, 1928, No. 48005 KU, probably ♂. × 2.

A member of one of the research teams on July 20, 1952, saw a family of least weasels along the edge of Seabee Creek at Umiat approximately 200 meters southwest from the west end of the airstrip. This family of five young and one adult lived in holes in the side of the bank which was three meters high. The banks and edges of the creek were densely grown to willows and alder. A few small willows and alders lined the top of the bank, beyond which lay grassy tundra. These young weasels were seen in the same set of holes on three consecutive days but were not seen thereafter. When these weasels were approached they called continually as they nervously ran back and forth along the bank near the entrances to the burrows in which they lived.

At Chandler Lake we observed several tundra voles that had been eaten by the least weasel; in getting at the flesh the weasels had turned the skins of the voles inside out.

The least weasel on the Arctic Slope is the ecological equivalent of the ermine of the Boreal regions of the western United States; both inhabit damp meadows supporting microtines.

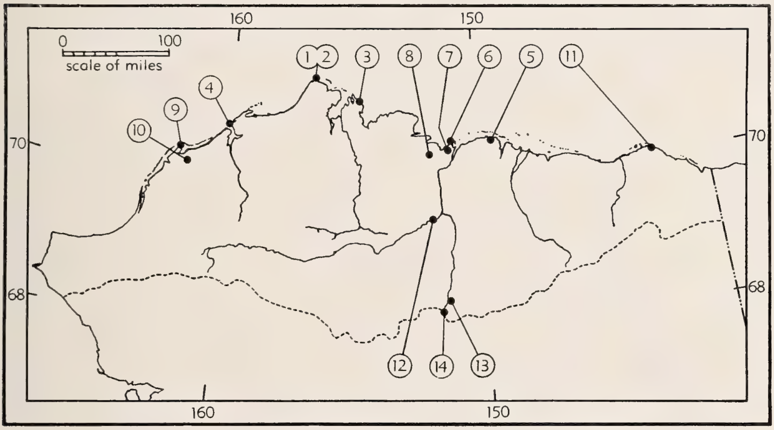


Fig. 95. Record stations of occurrence for *Mustela rixosa eskimo.*

Records of occurrence.—Specimen examined, 1; No. 43858, (12) 1½ mi. W and ¾ mi. N Umiat, 152°08′10″, 69°22′18″, 370 ft.

Additional records: (1) Point Barrow (W. Stone, 1900:45; Elliot, 1901:345; Trouessart, 1904-05:210; Miller, 1912b:96; 1924:118; Anthony, 1928:101; Hall, 1929:421; 1951:183); (2) Barrow (Hall, 1951:185); (3) [definite localities unspecified]: Arctic Coast of Alaska (Stone and Cram, 1905:240; Anderson, 1937:106); Arctic Slope on map (Burt and Grossenheider, 1952:38); (4) Wainwright (Hall, 1951:183); (5) west of Beechy [Beechey] Point (Hall, 1951:183); (6) Colville Delta (Anderson, 1947:64); (7) west edge of Colville River Delta (Hall, 1951:183); (8) Fish Creek Camp, 152°00′00″, 70°18′40″ (seen by Harry S. Newman in the autumn of 1950—*fide* J. W. Bee, MS, 25 July 1952); (9) Icy Cape (Anderson, 1947:64); (10) mountains back of Icy Cape [definite locality unspecified] (Hall, 1951:183); (11) Martin Point (Anderson, 1947:64); (13) Tolugak [Tulugak] Lake (Rausch, 1950c:465); (14) Anaktuvuk Pass (Rausch, 1951:175).

Mustela vison ingens (Osgood)

Mink (Itigiakpak)

Lutreola vison ingens Osgood, N. Amer. Fauna, 19:42, October 6, 1900, type from Fort Yukon, Alaska. (Also Anderson *in* Stefansson, 1913b:523; Rausch, 1950c:465.)

Mustela vison, Rausch, Arctic, 4:175, December 1951.

Putorius vison, Nelson and True, Mammals of Northern Alaska, Pt. 2, p. 247 *in* Arctic Series of publications No. 3 issued in connection with the Signal Service, U. S. Army by Nelson, 1884.

Description.—Weasellike mustelid, 2 to 2½ feet in over-all length; pelage dark reddish to chocolate brown often with isolated white spots on chin, chest or elsewhere on underparts; tail 6 to 7 inches long and nearly black toward tip.

External measurements (Dixon, 1938:151) of adult males from Alaska are: Total length, 737; tail, 183; hind foot, 76. Cranial measurements of males

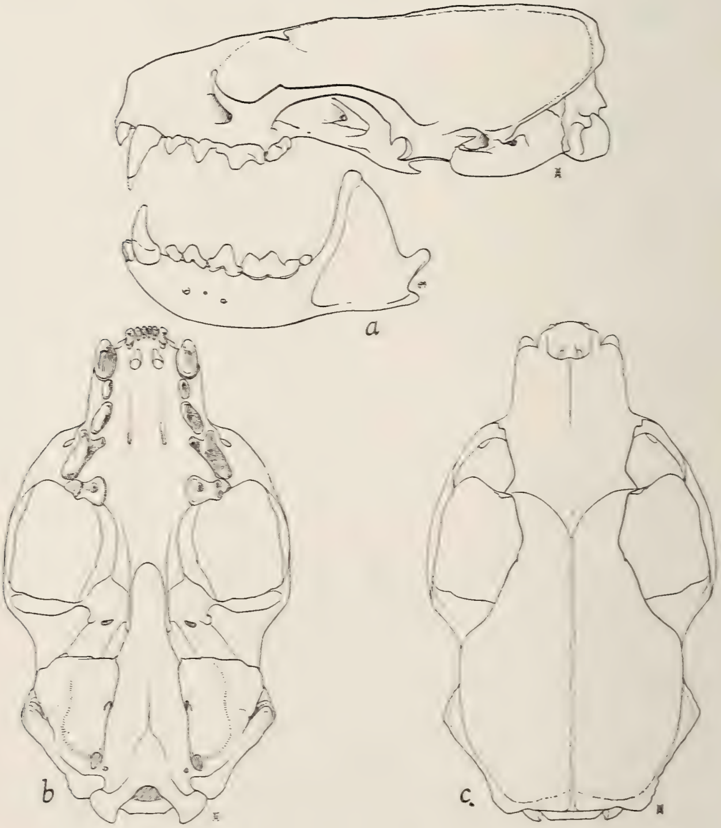


FIG. 96. Skull of *Mustela vison* [subspecies *energumenos* (Bangs)], Goose Creek, 5000 ft., Elko Co., Nevada, No. 74391 MVZ, ♂. × 1.

from Mission (Nelson and True *in* Nelson, 1887:247) are: Greatest length, 64-75; greatest width, 36-44.

Remarks.—The name *Mustela v. ingens* is provisionally used until specimens become available from the Arctic Slope. Rausch (1950c: 465) reports that there is a definite record for Chandler Lake.

Marvin Mangus, of the United States Geological Survey, on August 16, 1951, saw mink on the Scheenjek River at the mouth of Old Woman Creek, on the south side of the Brooks Range and informed us that the animal was common in rivers on the south side of that mountain range but that he had never seen the mink on the north side of the Brooks Range.

Harmon Helmericks told us that his friend, George Wood, an Eskimo living near the mouth of the Colville River, has trapped mink on the south side of the Brooks Range and saw tracks of the mink in 1949 on the north side of the Brooks Range near the mouth of the Kuparuk River and at the junction of the East Fork and West Fork of the Sagavanirktok River. Probably the mink is of only 'casual' occurrence north of the crest of the Brooks Range.

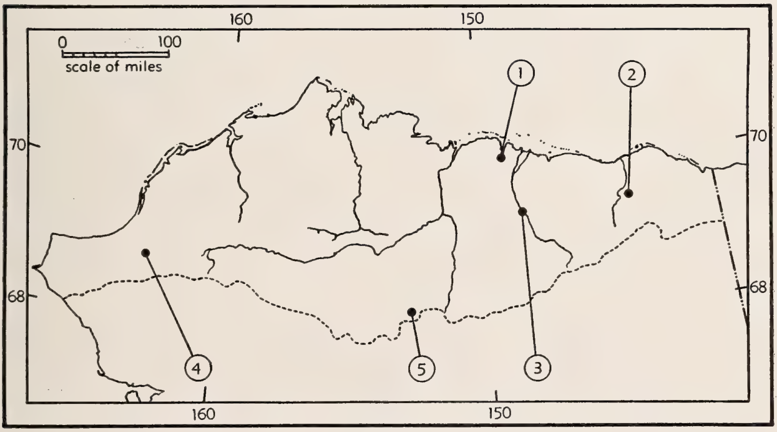


FIG. 97. Record stations of occurrence for *Mustela vison ingens.*

Records of occurrence.—Specimens examined, none.

Records: (1) Kuparuk River, 149°03′00″, 70°11′30″ (tracks noted by George Wood in 1949 and reported to us by Harmon Helmericks—*fide* J. W. Bee, MS, 8 September 1952); (2) Hulahula River near entrance to north side of Endicott Mountains (tracks noted by Anderson, 1913b:523); (3) Sagavanirktok River, 148°30′00″, 69°27′30″ (an animal seen by George Wood in 1949 and reported to us by Harmon Helmericks—*fide* J. W. Bee, MS, 8 September 1952); (4) nearly. . .to the coast (west coast) in latitude 68° to 70° (Nelson and true *in* Nelson, 1884:247); (5) Chandler Lake (tracks and definite record by Rausch, 1950c:465; 1951:175).

Gulo luscus luscus (Linnaeus)
Wolverine (Kavik)

[*Ursus*] *luscus* Linnaeus, Syst. Nat., ed. 10, 1:47, 1758, type locality Hudson Bay.

Gulo luscus, Richardson, List of Mammalia. . .*in* The Zoology of Capt. Beechey's Voyage to the Pacific and Behring's Strait. . .in H.M.S. Blossom . . .1825-28, p. 4, 1839. (Also True, 1884:609; Nelson and True *in* Nelson, 1887:248; Bailey and Hendee, 1926:15.)

Gulo luscus luscus, Anderson, Bull. Nat. Mus. Canada, 102; biol. ser. No. 31, p. 68, 1947. (Also Rausch, 1951:176).

Gulo gulo luscus, Rausch, Arctic, 6:114, July, 1953. (Regarded as a subspecies of *Gulo gulo* also by Degerbøl, mammals, in Report Fifth Thule Expedition to Arctic North America, 2(4): 35, 1935.)

Description.—Bearlike mustelid 3½ feet long; bushy tail making up 8 inches or so of this length; brownish, becoming paler anteriorly; broad stripe of paler brown on each side from shoulder to base of tail; five-toed, subplantigrade feet with strong claws; 38 teeth.

External measurements (from a dried skin, No. 52433) are approximately: Total length, 1066; tail, 201; hind foot, 158. Cranial measurements of three adult males (52433, 52383 and 52434, see specimens examined) are, respectively, as follows: Condylobasal length, 144, 148, 143; zygomatic breadth, 109, 106, 103; interorbital width, 43, 42, 41; palatal length, 76, 78, 75; length of maxillary tooth-row (C-M1), 54.7, 42.9, 54.2. Upper parts (52433) near (17′*n*) Mummy Brown, darkest posteriorly and lightest anteriorly; two broad stripes near (17′*l*) Mummy Brown anteriorly and becoming Pale Ochraceous-Buff over rump and base of tail; stripes begin on either shoulder, extend over sides and join on base of tail; distal two-thirds of tail, hind legs and forelegs like posterior part of back; proximal third of tail paler; underparts Mummy Brown except a posteriorly pointed "V" on chest and an irregular spot of Warm Buff on chin; muzzle like back; top of head buffy brown, grizzled and blending with back. Front feet larger and longer-clawed than hind feet. In specimen No. 52433, the dorsal and ventral lengths of the middle front claws, measured in a straight line, are 24.3 and 17.4 mm. The terminal pad on the third digit of the forefoot is 16.2 mm long and 8.2 mm wide.

The wolverine is scarce along the coast and on the Coastal Plain but is more abundant on the Plateau Province and in the Brooks Range. According to Rausch (1951:176) the Nunamiut Eskimos of the Anaktuvuk Pass region ordinarily kill three to six per year but in an occasional year take 12 to 15.

In the Brooks Range the wolverine commonly travels along the floors of the main canyons and not the steeper side canyons and slopes, and, like the grizzly bear, walks across muddy areas without seeking a route that provides drier footing. On the Plateau Province the wolverine occurs almost any place, but tends to travel on gentle slopes and along the edges of streams.

In summer, wolverines feed on caribou killed by wolves or on caribou that have died from natural causes. Wolverine tracks commonly are associated with caribou thoroughfares. In an eight mile section of Carnivore Canyon south of Lake Peters, there were wolverine tracks around six of the seven caribou carcasses found. In sequence, wolves, bears or wolverines, foxes, eagles, pigeon hawks and finally ravens feed on these carcasses. The raven ex-

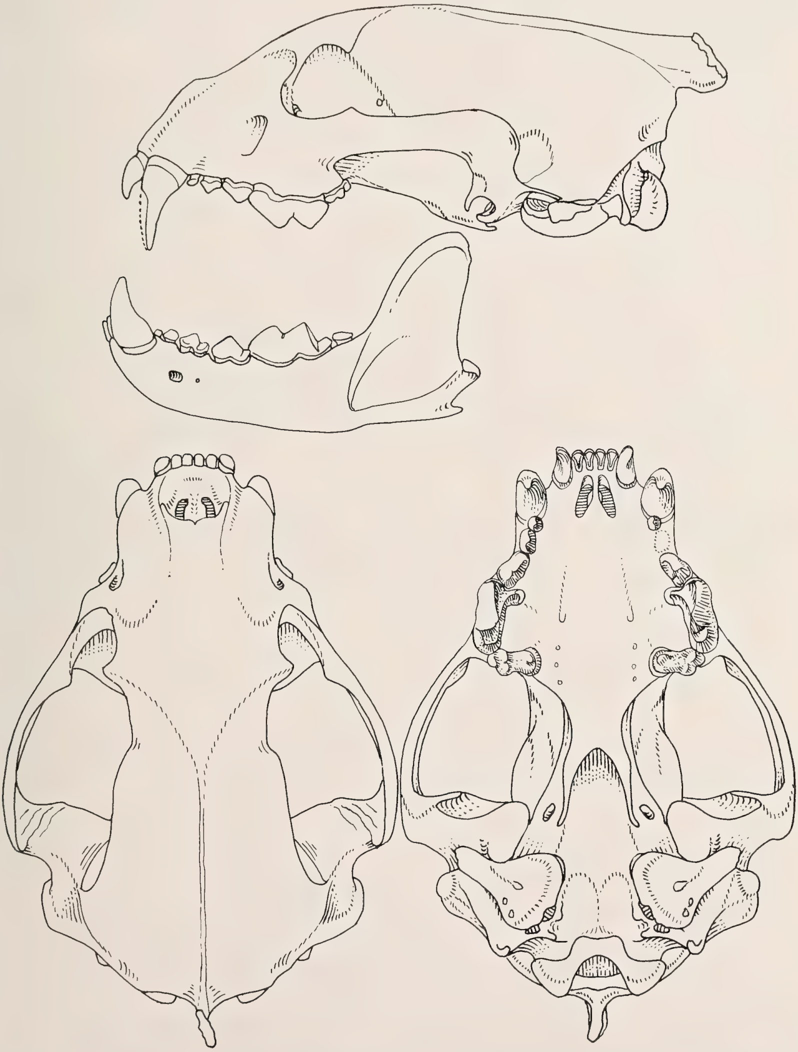


Fig. 98. Skull of *Gulo luscus luscus,* foothills of Brooks Range between Meade and Colville rivers, approximately 157°′30′, 69°20′, March 10, 1953, No. 52434 KU, probably ♂. × ½

tracts the flesh from small pockets between the vertebrae. According to Pete Sovalik, an Eskimo, the wolverine has been seen to kill young caribou by leaping from ledges or large rocks onto the back of the prey. Although the wolverine probably feeds on nearly all kinds of small rodents, we have observed diggings only for the ground squirrel and the singing vole. At Gubic in December, Frank Spinning watched two wolverines feeding on the carcasses of two male moose which had interlocking antlers.

On June 11, 1952, at Wolf Creek Camp, William A. Wyatte observed three wolverines together. In 19 other observations of the wolverine on the Arctic Slope, by several different persons, two were pairs and 17 were of single animals. The tracks seen by us were of solitary individuals. It seems that the wolverine ordinarily travels alone.

Inyualuruk reported to Rausch (1951:177) that one spring a wolverine, with two small young, was killed in the snow near the north edge of the Brooks Range.

The Eskimos, who have always hunted the wolverine, use its fur as a ruff around the face on the hood of their parkas.

On the Arctic Slope we had no reports of caches that were raided by the wolverine.

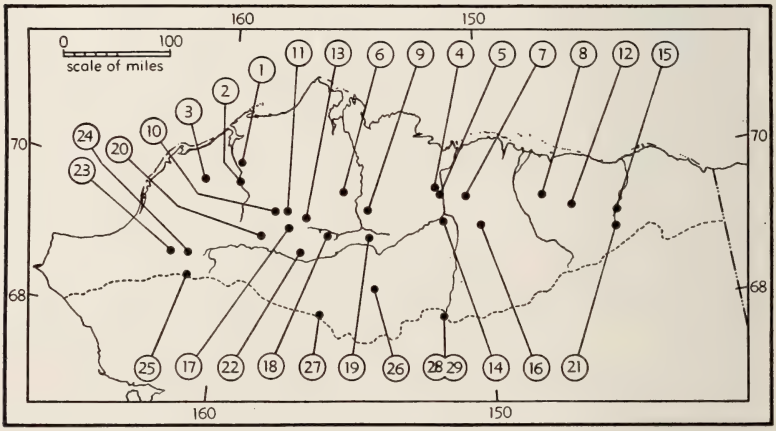


FIG. 99. Record stations of occurrence for *Gulo luscus luscus.*

Records of occurrence.—Specimens examined, 3 distributed by localities as follows: (8) Shaviovik River, approximately 147°40′, 69°42′, 1, a skin with skeleton, No. 52433, shot on March 23, 1953; (17) foothills of Brooks Range between Meade River and Colville River, approximately 157°30′, 69°20′, 1, a skull of No. 52434, shot on March 10, 1952; (22) near Colville River, 157°, 69°, 1, a skull, No. 52383, of a wolverine shot in February 1953.

Additional records (from James W. Bee, MS, 8 September 1952 unless otherwise indicated): (1) 2 mi. up Avalik River, 159°30′00″, 70°07′30″ (killed by Atanak, an Eskimo from Wainwright in 1950); (2) along river about 50 miles inland from Wainwright [definite locality not specified] (Bailey and Hendee, 1926:15); (3) all the northern parts of America [definite locality not specified] (Richardson, 1839:4); between Point Hope and Point Barrow [definite locality not specified] (Bailey and Hendee, 1926:15); entire mainland of Alaska (Nelson and True *in* Nelson, 1887:249); (4) Colville River, 151°21′, 69°55′ (killed by Joash Tukle in 1946); (5) Colville River, 151°14′, 69°49′ (killed by Joash Tukle in 1946); (6) East Oumalik, 155°32′00″, 69°48′20″ (seen by Norman Oie in 1949); (7) Itkillik River, 150°45′, 69°48′ (two killed by Joash Tukle in 1944); (9) Wolf Creek Camp, 154°32′, 69°38′ (seen by William L. Wyatte on June 11, 1952); (10) Meade River, 157°58′, 69°33′ (seen by Charles W. Whittington on August 5, 1949); (11) Meade River, 157°33′00″, 69°32′50″ (seen by Marvin Mangus on April 15, 1949); (12) East Fork Shaviovik River, 146°38′00″, 69°31′30″ (seen by Marvin Mangus on July 1, 1947); (13) Titaluk River, 156°43′00″, 69°29′30″ (seen by Marvin Mangus on April 15, 1949); (14) Gubic, 151°34′, 69°27′ (seen by Frank Spinning in December, 1951); (15) S end Lake Schrader, 145°09′30″, 69°24′15″, 2905 ft. (seen by Charles W. Whittington on July 15, 1945; Rausch, 1953: 114); (16) West Kuparuk River, 150°07′00″, 69°22′20″ (killed by Pete Savolik in February, 1938); (18) Kigalik Creek, 155°58′, 69°15′ (seen by Charles W. Whittington on August 15, 1947); (19) Ikpikpuk River, 154°28′, 69°13′ (seen by Charles W. Whittington on August 15, 1951); (20) Carbon Creek, 158°27′00″, 69°12′15″ (seen by Charles W. Whittington on June 1, 1949); (21) Lake James Robert, 145°10′00″, 69°16′30″ (tracks noted by James W. Bee on August 8, 1952); (23) between upper Utukok River and West Fork of Koblik, approximately 161°40′, 68°59′ (seen by Marvin Mangus on several occasions between May 30 and September 1, 1950); (24) Driftwood (seen by Charles Hummel in June 1950); (25) crest Brooks Range, head Utukok River, 161°08′, 68°33′ (seen by Charles Hummel in June, 1950); (26) Killik River, 154°07′00″, 68°30′30″ (seen by William Irving on July 14, 1951); (27) within 3 miles of Itivlik Lake and northwesterly along the Ahlasuruk River for approximately 8 miles (2 animals and other tracks seen by Irving and Paneak, 1954:204); (28) mouth of Anaktiktoak Creek (Rausch, 1951:176); (29) Anaktuvuk Pass (Rausch, 1951:176; 1953:115).

Lutra canadensis yukonensis Goldman

River Otter (Pamiuktuk)

Lutra canadensis yukonensis Goldman, Proc. Biol. Soc. Washington, 48: 180, November 15, 1935, type from Unalakleet, Norton Sound, Alaska.

Lutra canadensis, Rausch, Jour. Mamm., 31:466, November 21, 1950. (Also Rausch, 1951:177.)

Description.—Large (3¾ feet over-all) aquatic mustelid with long (14-inch) tail thick at base and tapering to tip; feet five-toed; toes webbed; pelage rich glossy brown, with pale silvery sheen on underparts; dense underfur short and protected by long guard hair; 36 teeth.

External measurements (Dixon, 1938:156) of specimens from Mount McKinley National Park are: Total length, 1119; tail, 356; hind foot, 112. Cranial measurements (Goldman, 1935:180) of the holotype are: Condylobasal length, 105.3; zygomatic breadth, 73.8; maxillary tooth-row, 34.9.

Remarks.—The name *Lutra canadensis yukonensis* is provisionally used until specimens become available from the Arctic Slope.

Marvin Mangus has never seen an otter on the north side of the Brooks Range but saw one adult and two young on the John River 30 miles south of the mouth of the Hunt Fork on August 15, 1951, and another on the Scheenjek River near the mouth of Old Woman Creek.

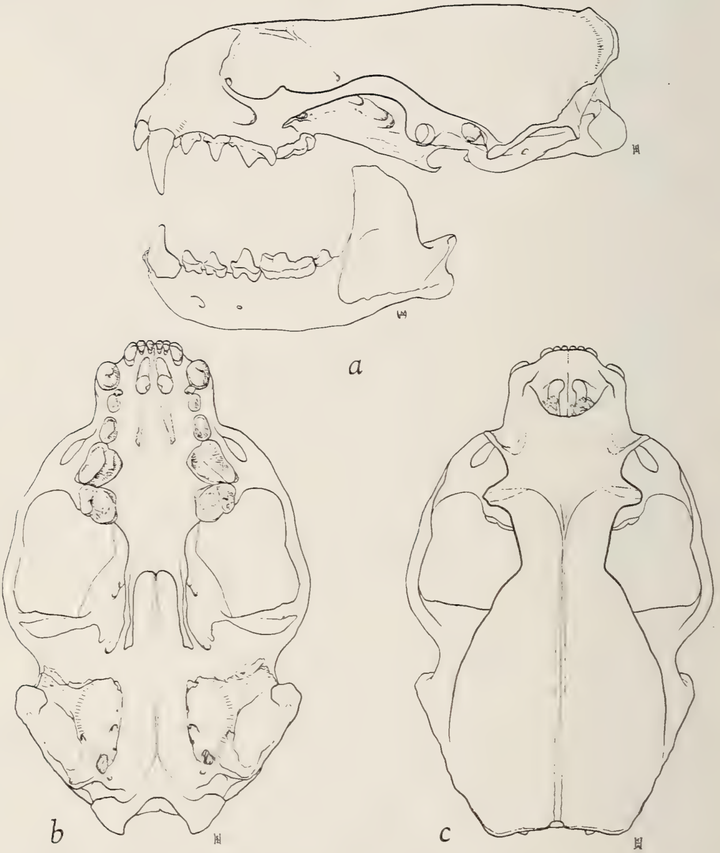


Fig. 100. Skull of *Lutra canadensis* [subspecies *sonora* Rhoads], Colorado River, 8 mi. upriver from Needles, San Bernardino Co., California, No. 61451 MVZ, ♂. × ½.

Records of occurrence.—Specimens examined, none.

Records: (1) Kuparuk River, 149°03′00″, 70°11′30″ (tracks noted by George Wood in 1949 and reported to us by Harmon Helmericks—*fide* J. W. Bee, MS, 8 September 1952); (2) Kanayut Lake about 15 miles northeast of Tolugak [Tulugak] Lake (sight record reported by Rausch, 1950c:466; 1951: 177).

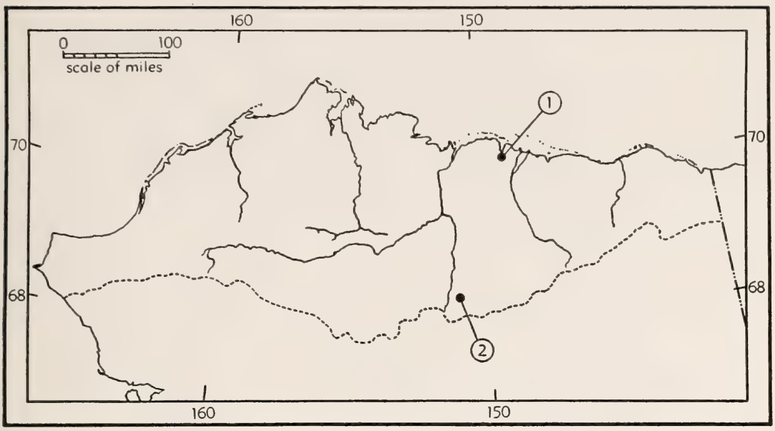


FIG. 101. Record stations of occurrence for *Lutra canadensis yukonensis.*

Lynx canadensis canadensis Kerr

Lynx (Niutuyik)

Lynx canadensis Kerr, Animal Kingdom,. . .vol. 1, systematic catalogue inserted between pages 32 and 33, description on p. 157, 1792, type from eastern Canada.

Lynx borealis canadensis, True, Proc. U. S. Nat. Mus., 7 (App., Cir. 29): 611, November 29, 1884.

Lynx canadensis mollipilosus W. Stone, Proc. Acad. Nat. Sci. Philadelphia, Pt. 1, p. 48, 1900, type from Wainwright Inlet, Point Barrow (*sic*), Alaska. (Also Bailey and Hendee, 1926:16.)

Lynx canadensis canadensis, Anderson, Mammals and birds of the Western Arctic District, Northwest Territories, Canada, reprinted from Canada's Western Northland, p. 108, July 9, 1937.

Felis lynx canadensis, Rausch, Arctic, 6:116, July 1953.

Description.—Short-tailed (5 inches) cat almost 3½ feet long with long legs, large feet, prominently tufted ears, ruff of fur around cheeks and neck, sharp and retractile claws, hind foot longer than tail, and long, dense pelage grizzled with brown and black.

Measurements of the holotype of *mollipilosus* from Wainwright Inlet (after W. Stone, 1900:48) are: Total length, 1040; tail vertebrae, 130; hind foot, approximately 260; basilar length, 113.5; mastoid breadth, 56.2; interorbital breadth, 28; length of palate, 49.2; length of mandible, 90.5; skull highly arched in frontal region; palate terminates posterior to molars; carnassial teeth well developed; 28 teeth.

The late Charles Brower (1942:245-246), resident at Barrow for more than fifty years, states that in occasional periods lynx migrate from inland "and appear along the coast by thousands."

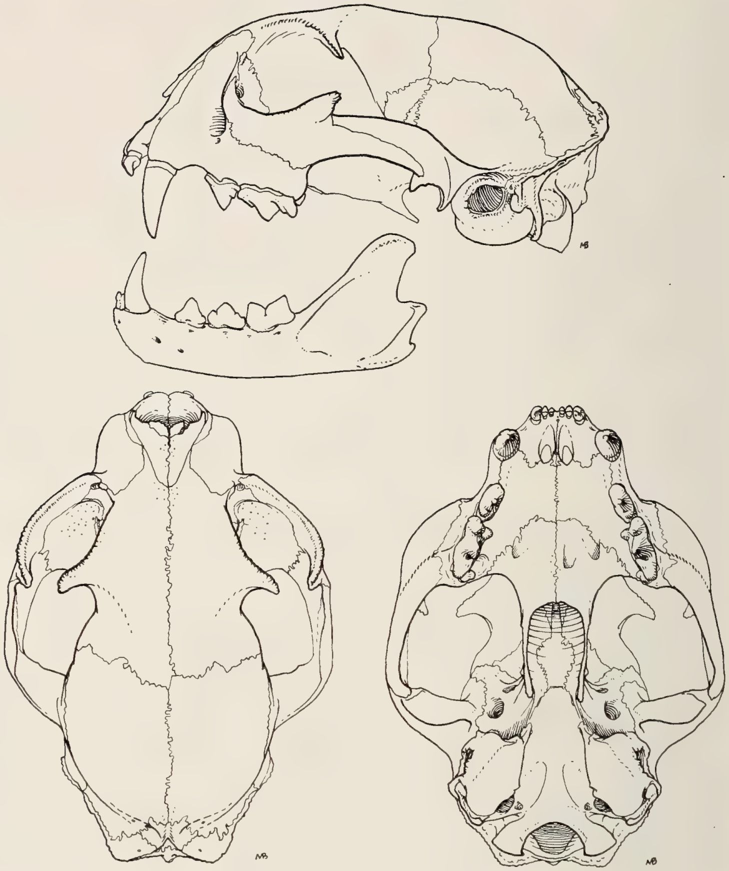


FIG. 102. Skull of *Lynx canadensis canadensis*, Kusilif, Alaska, No. 4214 MVZ, ♂. × ½. Lower jaw is of ♀, No. 48081 KU, Wonder Lake, Mt. McKinley Dist., Alaska. × ½.

Records of occurrence.—Specimens examined, none.

Records: (1) Point Barrow (reported by Clay Kaigelak—*fide* J. W. Bee, MS, 8 September 1952; Trouessart, 1904-05:277; Anthony, 1928:166; Anderson, 1937:108); (2) Barrow (Bailey and Hendee, 1928:16); (3) Wainwright Inlet (Stone, 1900:48; Miller, 1912b:119; 1924:160); (4) in willows of the barren country back of Wainwright (Bailey and Hendee, 1926:16); (5) along the coast [definite locality unspecified] (Brower, 1942:245); (6) lower Colville River (seen by Clay Kaigelak—*fide* J. W. Bee, MS, 8 September 1952); (7) [Arctic Slope, definite locality unspecified] (Burt and Grossenheider, 1952:55); (8) Tulugak Lake (Rausch, 1951:177).

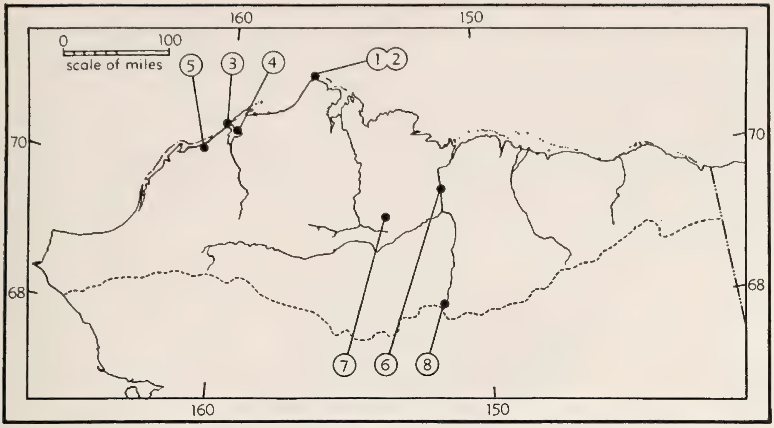

160
150
0
100
scale of miles
5
3
4
1
2
70
68
7
6
8
160
150

FIG. 103. Record stations of occurrence for *Lynx canadensis canadensis.*

Callorhinus ursinus cynocephalus (Walbaum)
Northern Fur Seal (Kasigiak)

Siren cynocephala Walbaum, in Artedi, Petr. Artedi. . .ichthyologica, pt. 3, Genera piscium, p. 560, 1792, based on the sea ape of Steller; see Stejneger, Georg Wilhelm Steller. . .,p. 285, August 1936.

Callotaria ursina, W. Stone, Proc. Acad. Sci. Philadelphia, 52:43, March 24, 1900.

Callorhinus alascanus, Anderson *in* My life with the Eskimo by Stefansson, p. 525, 1913.

Callorhinus ursina cynocephala, Anderson, Bull. Nat. Mus. Canada, No. 102, biol. ser. No. 31, p. 77, 1947.

Range.—Casual, Arctic Ocean.

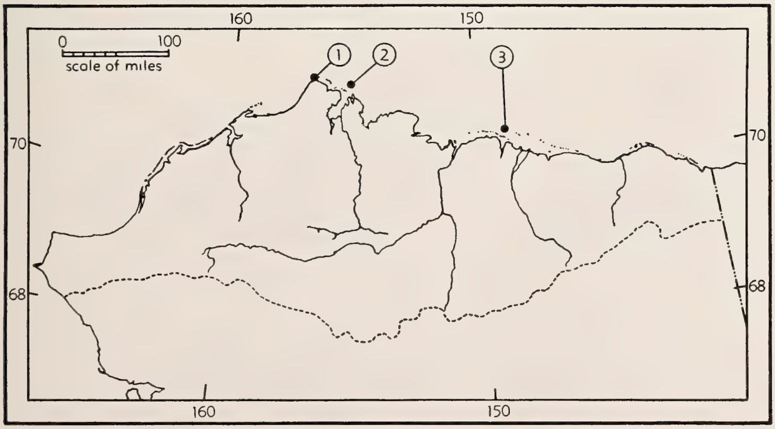
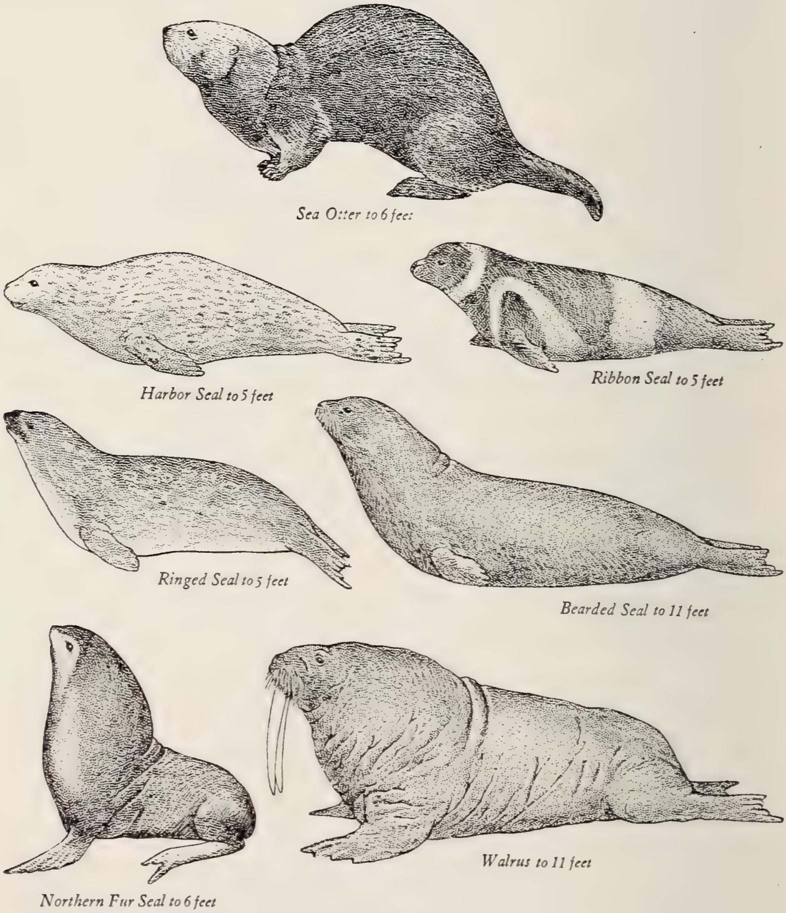

160
150
0
100
scale of miles
1
2
3
70
68
160
150

FIG. 104. Record stations of occurrence for *Callorhinus ursinus cynocephalus.*

Description.—Length, males 6 feet, females 4 feet; males weigh up to 700 pounds; pelage in males dark brown to blackish on upper parts, gray on shoulders, reddish on underparts; in females, upper parts grayish brown and underparts reddish; hind feet reversible for walking (see fig. 105); rostrum of skull short, wide and convex; 34 or 36 teeth (see figs. 107, 108).

Records of occurrence.—Specimens examined, none.

Records: (1) Point Barrow (W. Stone, 1900:43, obtained August 17, 1897, 48 inches long; Anderson, 1947:78; reported by Pete Sovalik as only rarely taken—*fide* J. W. Bee, MS, 8 September 1952); (3) east of Point Barrow (Anderson *in* Stefansson, 1913b:525).



Sea Otter to 6 feet

Harbor Seal to 5 feet

Ribbon Seal to 5 feet

Ringed Seal to 5 feet

Bearded Seal to 11 feet

Walrus to 11 feet

Northern Fur Seal to 6 feet

FIG. 105. Seals, walrus and sea otter.

Odobenus rosmarus divergens (Illiger)
Walrus (Avik)

[*Trichechus*] *divergens,* Illiger, Abhandl. preuss. Akad. Wiss. Berlin, 1804-1811, p. 68, 1815. Type locality as for *T. obesus* below.

? *Trichechus obesus Illiger,* Abhandl. preuss. Akad. Wiss. Berlin, 1804-1811, p. 64, 1815 (*Nomen nudum*). Type from about 35 miles south of Icy Cape, Alaska. (Also Elliot, 1901:358.)

Trichechus rosmarus, Cuvier, Le regne animal distribué d'après son organisation, pour servir de base a l'histoire naturelle des animaux et d'introduction a l'anatomie comparée, Paris, 1:168, 1817. (Also Richardson, 1839:6.)

Rosmarus obesus, Dall *in* The marine mammals of north-western coast of North America, by Scammon, San Francisco: John H. Carmany and Company, New York: G. P. Putnam's Sons, p. 176, 1874.

Odobaenus obesus, J. A. Allen, U. S. Geol. Surv. Dept. Inter. Misc. Publ. No. 12, p. 147, 1880. (Also Murdock *in* Ray, 1885:97; Nelson and True *in* Nelson, 1887:233, 267; W. Stone, 1900:43; Preble, 1908: 241.)

Odoboenus obesus, Elliot, Report of the Sea Islands of Alaska, Dept. Inter., Washington, p. 95, 1884.

Odobaenus rosmarus, MacFarlane, Proc. U. S. Nat. Mus., 28:725, 1905. (Also MacFarlane, 1908:227.)

Odobenus obesus, Anderson, *in* My life with the Eskimo by Stefansson, New York, MacMillan Co., p. 525, 1913.

Odobenus divergens, Stejneger, Proc. Biol. Soc. Washington, 27:145, July 10, 1914. (See also Bailey and Hendee, 1926:18; Collins, 1940:138; G. M. Allen, 1942:469; Anderson, 1937:102; 1947:81.)

Odobenus rosmarus divergens, Barabash-Nikiforov, Jour. Mamm., 19:427, November 14, 1938. (Also Ellerman and Morrison-Scott, 1951:325.)

Range.—Arctic Ocean.

Description.—Body ponderous, length 10-11 feet, neck massive, head proportionally small with upper canines projecting downward as two white tusks, muzzle blunt and broad, tail vestigial, 5 toed and bearing flat nails, males ⅓ larger than females, weight 1 to 1½ tons, hairless except for stiff vibrissae, skin thick and wrinkled; see fig. 105 on page 220.

According to Pete Sovalik, walrus are frequently taken and at different times in the year both at Barrow Village and Wainwright.

Records of occurrence.—Specimens examined, none.

Records: (1) Point Barrow (J. A. Allen, 1880:175; Murdock *in* Ray, 1885: 97; Nelson and True *in* Nelson, 1887:233; W. Stone, 1900:43; MacFarlane, 1905:725; Anderson *in* Stefansson, 1913b: 525; Leffingwell, 1919:63; Bailey and Hendee, 1926:19; Anderson, 1937:102; Collins, 1940:138-139; reported by Pete Sovalik as frequently taken every year—*fide* J. W. Bee, MS, 5 September 1952); (2) several miles inland at Point Barrow (Anderson *in* Stefansson, 1913b:525); (3) 71°07′ N (Beechey, 181:382, "herds of amphibious animals [walruses]"; (4) "walruses" [between Cape Smythe and Cape Franklin, definite locality unspecified] (Beechey, 1831:436); (5) Northern Hemisphere above the latitude of 45° (Dall *in* Scammon, 1874:178); all parts of the Arctic seas (Cuvier, 1817:168); Behring Straits. . .to the northward (Richardson, 1839:6); between Point Barrow and the region of Point Beechey (Elliot, 1884:101); Arctic Ocean (Trouessart, 1904:281); northward to Point Barrow (Collins, 1940:138); Arctic waters (Burt and Grossenheider, 1952:62); (6) Sea Horse Islands (Collins, 1940:138); (7) Pitt Point (skull and skeleton picked up by Clifford Fiscus—*fide* J. W. Bee, MS, 8 September 1952); (8) Wainwright (Bailey and Hendee, 1926:19; Collins, 1940:138-139; reported by Pete Sovalik as frequently taken every year—*fide* J. W. Bee, MS, 5 September 1952); (9) 8 mi. W and 2 mi. N Atigaru Point (skull picked up by Clifford Fiscus in summer 1952—*fide* J. W. Bee, MS, 8 September 1952); (10) Cross Island, a little east of the Colville River (Anderson, 1913b:526); (11) between Point Barrow and the region of Point Beechey (Elliot, 1884:101); (12) [definite localities not specified]: between Point Barrow and the [international boundary] (MacFarlane, 1905:725; 1908:277; Preble, 1908:241); northern Alaska Coast

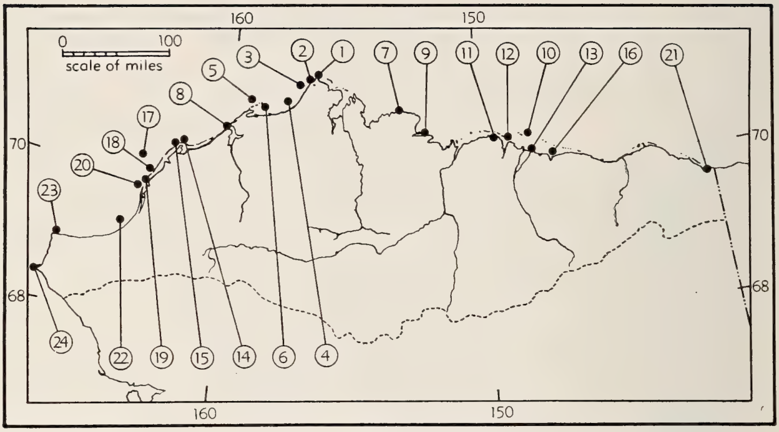


FIG. 106. Record stations of occurrence for *Odobenus rosmarus divergens.*

(Anderson, 1937:102); north coast of Alaska [to international boundary] (Anderson, 1947:81); (13) 50 miles west of Flaxman Island (Leffingwell, 1919:64); (14) Icy Cape (Collins, 1940:138-139); (15) near Cape Lisburne . . .north to Point Barrow (Nelson and True *in* Nelson, 1887:268); Point Hope to Point Barrow (Nelson and True *in* Nelson, 1887:269);. . .north to Point Barrow (Anderson, 1947:81); (16) on a sandspit off mouth of Shaviovik River west of Flaxman Island (Anderson *in* Stefansson, 1913b:526); (17) "prodigious number of sea horses, they be in herds of many hundreds," 70°06′, 196°42′ (Cook, 1784:456); (18) type locality; (19) Point Lay (Collins, 1940:138-139); (20) "great many. . .walruses" [between Cape Beaufort and Icy Cape but definite locality unspecified] (Beechey, 1831:372); (21) Demarcation Point (Bailey and Hendee, 1926:19); (22) "roaring of the sea horses" [between the boat and land, between 70°06′, 196°42′ and Cape Lisburne] (Cook, 1784:459); (23) Cape Lisburne (Nelson and True *in* Nelson, 1887:270); Lisburne to 200 miles north (Bernard, 1925:100); from entrance to Maryatt Inlet to Cape Lisburne (Bernard, 1925:101); Cape Lisburne (Collins, 1940:140); (24) Point Hope (Bailey and Hendee, 1926:19; Collins, 1940:138, 140).

Phoca vitulina richardii (Gray)
Harbor Seal (Kasigiak)

Halicyon richardii Gray, Proc. Zool. Soc. London, pt. 1, p. 28, July 1864, type from Vancouver Island, British Columbia.

Phoca vitulina, True, Proc. U. S. Nat. Mus., 7(App., Cir., 29):607, November 29, 1884. (Also Murdock *in* Ray, 1885:95; Turner, 1886:206; Nelson and True *in* Nelson, 1887:233, 264.)

Phoca largha, W. Stone, Proc. Acad. Nat. Sci. Philadelphia, 52:43, March 24, 1900.

Phoca ochotensis macrodens J. A. Allen, Bull. Amer. Mus. Nat. Hist., 16:483, December 12, 1902, in part, type from Avatcha Bay, Kamchatka.

Phoca richardii pribilofensis, Bailey and Hendee, Jour Mamm., 7:16, February 15, 1926.

Phoca richardii richardii, Anderson, Mammals and birds of the western Arctic District *in* Canada's Western Northland, Canada, p. 101, July 9, 1937.

Phoca vitulina richardii, Doutt, Ann. Carnegie Mus., 29:117, May 12, 1942. (Also Anderson, 1947:78.)

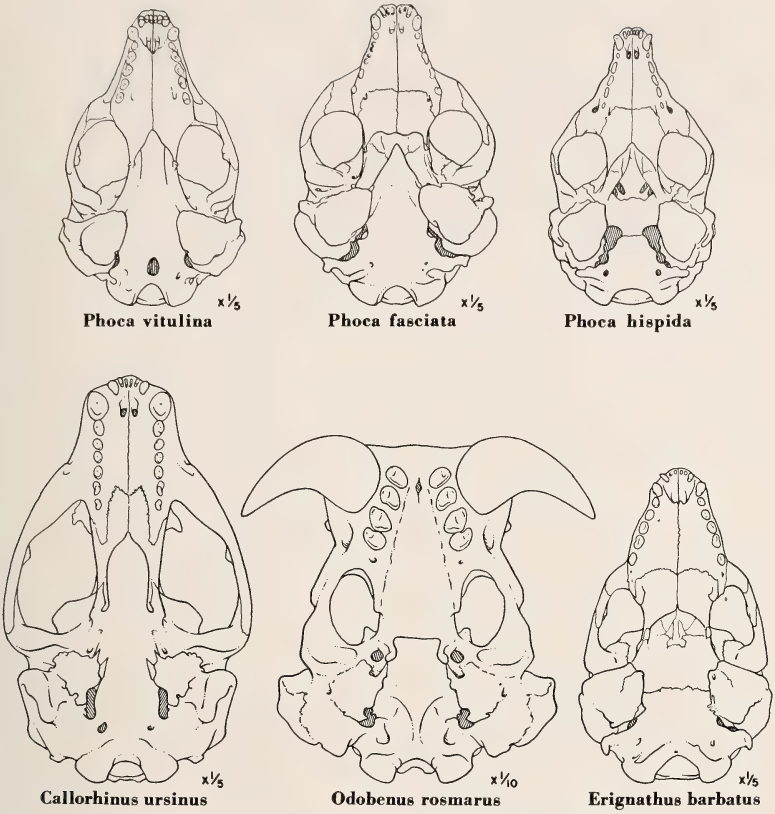

x⅕
Phoca vitulina
x⅕
Phoca fasciata
x⅕
Phoca hispida
x⅕
Callorhinus ursinus
x1/10
Odobenus rosmarus
x⅕
Erignathus barbatus

FIG. 107. Ventral views of skulls of seals and walrus.

Phoca vitulina concolor, after Doutt (Ann. Carnegie Mus., vol 29, fig. 1 of pl. 9, 1942). × ⅕.
Phoca fasciata, after Doutt (*op. cit.,* fig. 2, pl. 10). × ⅕.
Phoca hispida beaufortiana, Point Barrow, 71°22′10″, 156°30′00″, Alaska, September 11, 1952, No. 51564 KU, ♀. × ⅕.
Callorhinus ursinus cynocephalus, Pacific Grove, California, No. 2873 KU, sex ?. × ⅕.
Odobenus rosmarus [subspecies *rosmarus* Linnaeus], Ingelfield Gulf, North Greenland, August 1895, No. ? 2654 KU, ♂. × 1/10.
Erignathus barbatus [subspecies *barbatus* (Erxleben)], Holsteinberg, Greenland, No. 2881 KU, sex ?. × ⅕.

Range.—Arctic Ocean.

Description.—Size and shape as in ringed seal; weight 250 pounds; body widest in midsection; neck short and slim; eyes large; no external ears; hind flippers directed posteriorly and not reversible; pelage spotted, yellowish with brown to blackish spots; teeth 34, see figs. 105, 107 and 108.

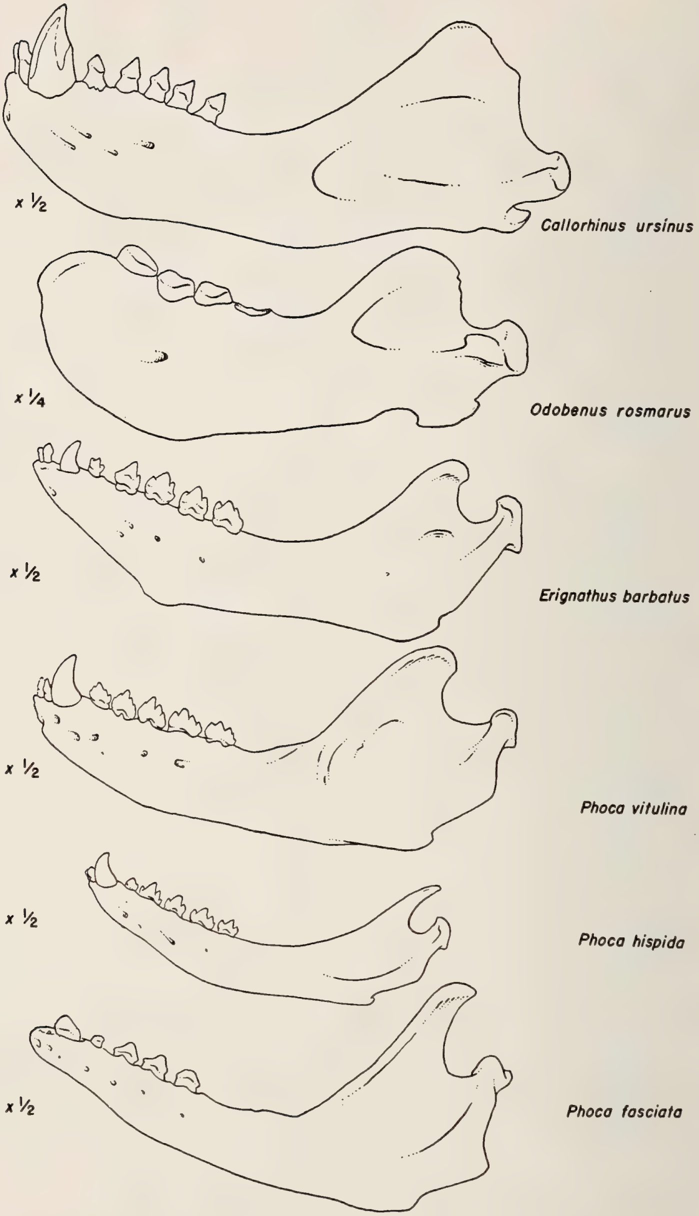

x ½
Callorhinus ursinus
x ¼
Odobenus rosmarus
x ½
Erignathus barbatus
x ½
Phoca vitulina
x ½
Phoca hispida
x ½
Phoca fasciata

Fig. 108. Lateral views of left lower jaws of same specimens shown in fig. 107.

Clifford Fiscus found the harbor seal common from Pitt Point to Harrison Bay in the summer of 1952. There were 10 individuals in one group.

Records of occurrence.—Specimens examined, none.

Additional records: (1) Point Barrow (Nelson and True *in* Nelson, 1887: 233, 264; W. Stone, 1900:43; J. A. Allen, 1902:484; Anderson, 1937:101; Doutt, 1942:121; seen by J. W. Bee on September 11, 1952); (2) Pergniak in Elson Lagoon (Murdock *in* Ray, 1885:95); (3) Arctic regions (True, 1884: 607); entire coast line [of Alaska] (Turner, 1886:206); Arctic Ocean (Trouessart, 1904:286); coast seas of Arctic America (MacFarlane, 1908:229); in Arctic Ocean [from Cape Thompson to international boundary] (Anderson, 1947:78); Arctic (Burt and Grossenheider, 1952:61); (4) Atanik (Bailey and Hendee, 1926:16); (5) Pitt Point (10 in one group seen by Clifford Fiscus in summer of 1952—*fide* J. W. Bee, MS, 8 September 1952); (6) Wainwright (Murdock *in* Ray, 1885:95); (7) in the extensive lagoons near Icy Cape (Bailey and Hendee, 1926:16); (8) several miles up the Colville River (reported by Pete Sovalik—*fide* J. W. Bee, MS, 8 September 1952); (9) Kaolak River, 159°47′40″, 70°11′15″ (seen by Atanak and party on July 17, 1951 —*fide* J. W. Bee, MS, same date); (10) Cape Lisburne south (Nelson and True *in* Nelson, 1887:264).

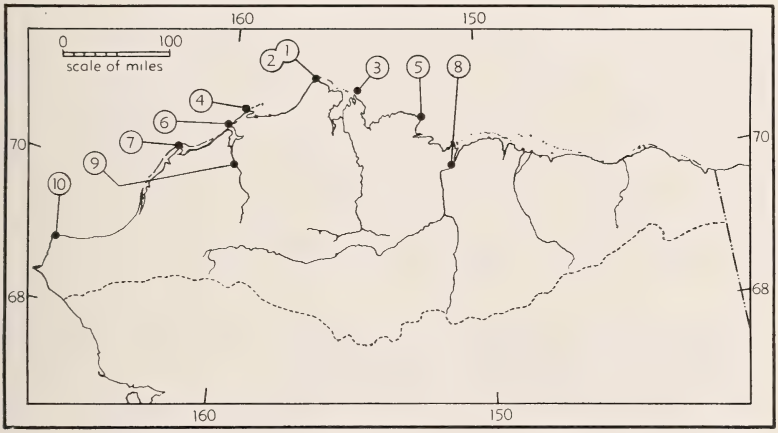


FIG. 109. Record stations of occurrence for *Phoca vitulina richardii.*

Phoca fasciata Zimmermann
Ribbon Seal (Kaigulik)

Phoca fasciata Zimmermann, Geographische Geschichte. . .,3:277, 1783, type from Kurile Islands, Japan. (Also True, 1884:607; Nelson and True *in* Nelson, 1887:233,261; Bailey and Hendee, 1926:16; Doutt, 1942:95; Anderson, 1947:193.)

Histriophoca fasciata, Murdock, *in* Expedition to Point Barrow, Alaska by P. H. Ray, 48th Congress, 2nd Session, Exec. Doc. No. 44, p. 97, 1885. (Also J. A. Allen, 1902:474.)

Range.—Arctic Ocean.

Description.—Size and shape like ringed seal, pelage brown with contrasted bands of yellow to ochraceous yellow around neck, front flippers and rump; see fig. 105 on page 220.

According to Pete Sovalik, ribbon seal are taken only rarely at Point Barrow.

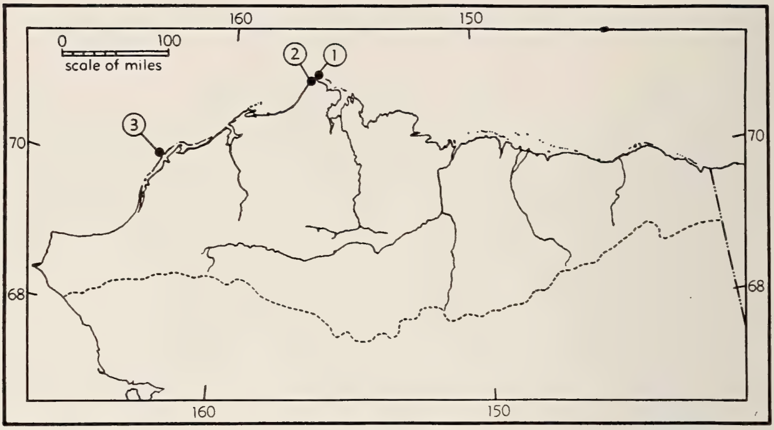


FIG. 110. Record stations of occurrence for *Phoca fasciata.*

Records of occurrence.—Specimens examined, none.

Records: (1) Point Barrow (Murdock *in* Ray, 1885:97; Nelson and True *in* Nelson, 1887:261; J. A. Allen, 1902:474; Bailey and Hendee, 1926:17; Doutt, 1942:95; reported by Pete Sovalik—*fide* J. W. Bee, MS, 8 September 1952); (2) Cape Smythe (Murdock *in* Ray, 1885:97; Nelson and True *in* Nelson, 1887:233); (3) [from Cape Thompson] north to. . .Point Barrow [definite locality unspecified] (Anderson, 1947:193; Alaska northward [definite locality not specified] (Burt and Grossenheider, 1952:61).

Phoca hispida beaufortiana Anderson
Ringed Seal (Natchik)

Phoca hispida beaufortiana Anderson, Ann. Rep. Provancher Soc. Nat. Hist., Quebec, 1942, p. 25, September 7, 1943, type from Cockburn Point, Dolphin and Union Strait, Mackenzie District Northwest Territories, Canada, lat. 68°55′29″ N., long. about 115°10′ W.

Phoca foetida, True, Proc. U. S. Nat. Mus., 7 (App., Cir., 29); 607, November 29, 1884. (Also Murdock *in* Ray, 1885:95; Turner, 1886:206; Nelson and True *in* Nelson, 1887:233, 262; Stone, 1900:44.)

Phoca hispida, Elliot, Field Columbian Museum, Zool. Series, 2:364, 1901. (Also Stone and Cram, 1905:217; Anderson *in* Stefansson, 1913b:526; Bailey and Hendee, 1926:17; Anderson, 1937:101.)

Phoca (Pusa) hispida, J. A. Allen, Bull. Am. Mus. Nat. Hist., 16:477, 1902.

Range.—Arctic Ocean.

Description.—Length 4½ feet to 5 feet; on foreflipper, first digit longest; upper parts dark brownish to blackish brown with small irregular yellowish rings; underparts yellowish to strong ochraceous yellow; rings large and crowded on upper chest and throat; flippers and claws black; see figs. 105, 107 and 108.

The ringed seal is common at Point Barrow and at Wainwright according to Pete Sovalik. Clifford Fiscus told us that this seal frequently is seen at Pitt Point in summer.

Records of occurrence.—Specimens examined, 1(51564) from (3) Point Barrow, 156°30′00″, 71°22′10″.

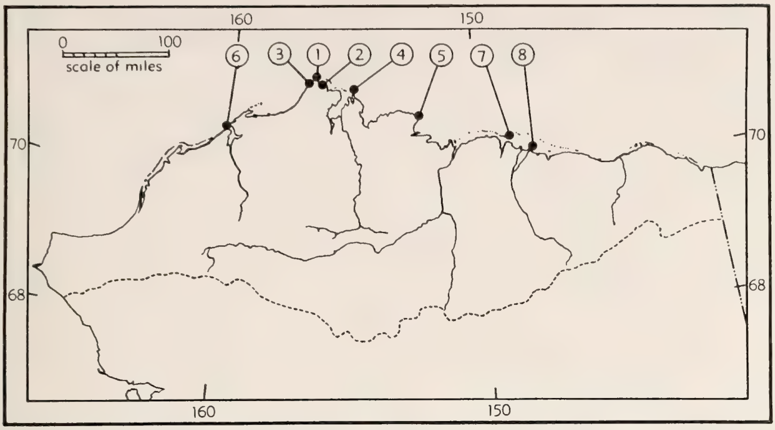


FIG. 111. Record stations of occurrence for *Phoca hispida beaufortiana.*

Records: (1) Point Barrow (Murdock *in* Ray, 1885:95; Nelson and True *in* Nelson, 1887:262, 263; W. Stone, 1900:44; J. A. Allen, 1902:477); (2) Elson Bay (Murdock *in* Ray, 1885:95); (4) all along Arctic shore (Turner, 1886: 206); circumpolar south to. . .northern shores of Bering Sea (Elliot, 1901: 364); Arctic Ocean (Trouessart, 1904-05:287); Arctic seas (Stone and Cram, 1905:217); circumpolar (Anthony ,1928:176); Arctic Ocean (Anderson, 1937: 101); Arctic Coast of Alaska (Anderson, 1947:79); Arctic (Burt and Grossenheider, 1952:61); (5) Pitt Point (seen by Clifford Fiscus in summer of 1952—*fide* J. W. Bee, MS, 8 September 1952); (6) Wainwright (Bailey and Hendee, 1926:17); (7) along coast of Bering Sea to [international boundary] (Anderson *in* Stefansson, 1913b:526); (8) Foggy Island Bay on 21 July 1837 incredible number of seals were seen on the shores of this bay [probably this species] (Simpson, 1843:125).

Erignathus barbatus nauticus (Pallas)
Bearded Seal (Ugruk)

Phoca nautica Pallas, Zoographia Rosso-Asiatica, . . .1:108, 1811, type from Okhotsk Sea.

Erignathus barbatus, True, Proc. U. S. Nat. Mus., 7 (App., Cir. 29): 607, November 29, 1884. (Also Murdock *in* Ray, 1885:96; Nelson and True *in* Nelson, 1887:233, 259; W. Stone, 1900:43; J. A. Allen, 1902:473; Stone and Cram, 1905:218; MacFarlane, 1908:231; Anderson *in* Stefansson, 1913b: 526; Anderson, 1937:102.

Phoca barbata, Elliot, Field Columbian Mus., Zool. Series, 2:362, 1901.

Erignathus barbatus nauticus, Osgood, N. Amer. Fauna, 24:47, November 23, 1904. (Also Bailey and Hendee, 1926:17.)

Range.—Arctic Ocean.

Description.—Length 10-12 feet; bristles on each side of long, flattened muzzle; skin thick and white; grayish to yellow, darkest along back; see figs. 105, 107 and 108.

Atanak, an Eskimo from Wainwright, had a boat which was covered with the hide of the bearded seal. Several of the large boats at Barrow Village were covered with the hide of this seal. A skull from a subadult was purchased by Edward Campbell from Clay Kaigelak and measured 180 millimeters in condylobasal length.

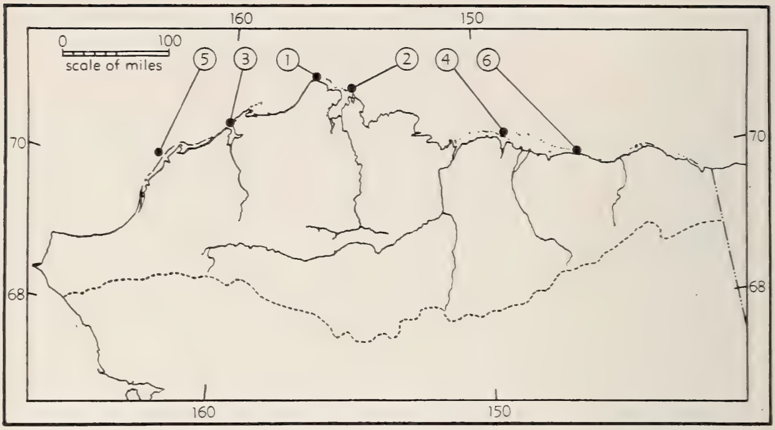


FIG. 112. Record stations of occurrence for *Erignathus barbatus nauticus.*

Records of occurrence.—Specimens examined, none.

Records: (1) Point Barrow (Murdock *in* Ray, 1885:96; W. Stone, 1900:43; J. A. Allen, 1902:474); (2) Wainwright (Bailey and Hendee, 1926:18); (3) along coast to Point Barrow (Nelson and True *in* Nelson, 1887:233, 260; Alaska Coast from [Cape Thompson] northward (MacFarlane, 1908:231); (4) north coast of Alaska east of Point Barrow (Anderson *in* Stefansson, 1913b: 526); (5) circumpolar (Elliot, 1901:362); Arctic Ocean (Trouessart, 1904-05:285); Arctic seas (Stone and Cram; 1905:218); Polar seas (Anthony, 1928:177); Alaskan waters (Anderson, 1937:102); [Polar waters] of Alaska (Burt and Grossenheider, 1952:61); (6) Flaxman Island (Leffingwell, 1919: 64).

Alces alces gigas Miller

Moose (Tutuvak)

Alces gigas Miller, Proc. Biol. Soc. Washington, 13:57, May 29, 1899, type from north side of Tuctumena Lake, Kenai Peninsula, Alaska. (Also Elliot, 1901:38.)

Alces machlis, True, Proc. U. S. Nat. Mus., 7 (App., Cir. 29):592, November 29, 1884. (Also Lydekker, 1898:52.)

Alce americanus, A. J. Stone, Bull. Amer. Mus. Nat. Hist., 13:47, 1900.

A[lces]. a[mericana]. gigas, Peterson, Occ. Papers Royal Ontario Mus. Zool., 9:2, 1950. (Also Rausch, 1950c:466; 1951:185.)

Alces alces gigas, Peterson, Cont. Royal Ontario Mus. Zool. and Paleo., No. 34, fig. 1 facing p. 1 (probably Umiat as locality on map), October 15, 1952. (First regarded as a subspecies of *Alces alces* by Bobrinskiy, Kuznetsov and Kuzyakin in 'Opredelitel' mlekopitayushchikh S.S.S.R., Moscow, 19 44; Ellerman and Morrison-Scott (1951:373) include the range of *Alces alces* in "northern North America".) (Also Rausch, 1953:139.)

Alces machlis gigas, Lydekker, Great and small game of Europe, p. 49, 1901.

Alces americana, Leopold and Darling, Wildlife in Alaska, The Ronald Press Company, New York, p. 83, 1953.

Description.--Largest deerlike mammal; up to 6 ½ feet tall at shoulder; hips lower than shoulder; muzzle broad and inflated; throat having bell (hanging growth of skin); antlers palmate with projecting prongs; females without antlers; pelage blackish brown to black, paler on underparts and lower legs.

Measurements (from Miller, 1899:58-59) of adult male from Kenai Peninsula: Total length, 3149; tail, 101; ear from crown, 304; height at shoulder, 2034; greatest length of skull, 633; zygomatic breadth, 228.

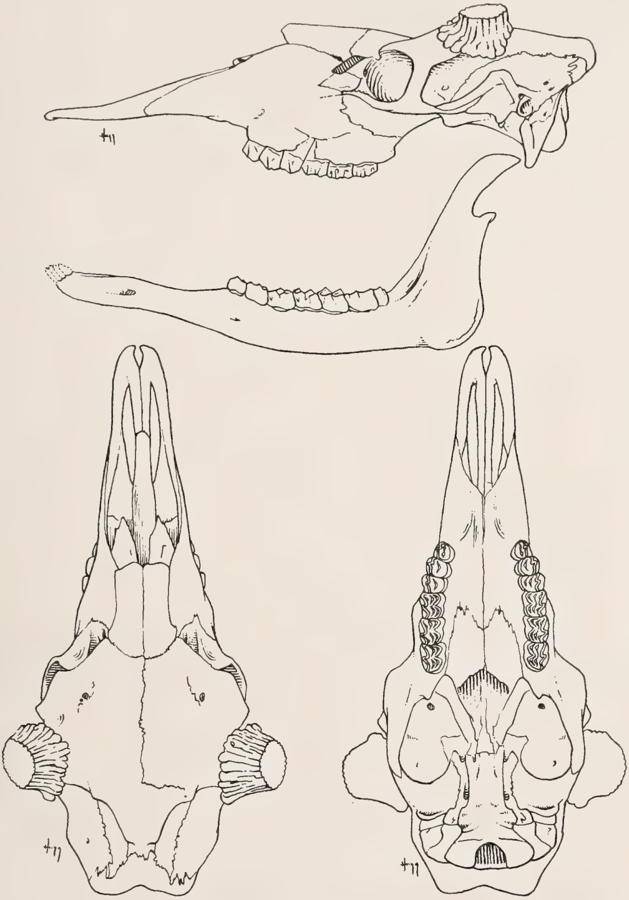


Fig. 113. Skull of *Alces alces* [subspecies *andersoni* Clinton]. Lake of the Woods, Minnesota, No. 2477 KU, ♂. × ⅛.

Remarks.—The name *Alces alces gigas* is tentatively employed for the moose on the Arctic Slope until material becomes available for comparison with *gigas* to the south of the Brooks Range and *andersoni* to the east of the Arctic Slope.

The moose is a common mammal in the riparian communities along the major rivers. More precisely, it occurs in the valleys of the Colville River and Maybe Creek east to at least the valley of the Canning River, and from the crest of the Brooks Range north to the Arctic Ocean. These animals have been seen between the Colville River (at least as far west as Awuna River) and the Canning River. Ralph Steiner told us that he counted 100 moose in the valley of the Colville River between Umiat and a point 100 miles to the west, or approximately one per air-mile along the river. William L. Wyatte reported 36 moose along the river near Grandstand in the winter of 1951-52. In the summer of 1952, Harmon Helmericks counted 29 moose while he was flying from Anaktuvuk Pass to the mouth of the Colville River and believes that he saw the entire population along the rivers between these two points. In the winter of 1935, Joash Tukle observed several moose traveling north near the mouth of the Itkillik River although the moose generally remain there in that area throughout the winter. William P. Brosge, on July 4, 1952, saw one adult and one calf two miles down the Ivashak River from the East Fork of the Ivashak River. These were in the rugged section of the Brooks Range.

On July 22, 1952, we saw a moose lying among willows along a small creek one-third of a mile west of the Canning River some 10 miles north of the Brooks Range. In the western part of the Brooks Range and Plateau Province at the head of the Colville drainage, Charles Hummel saw no moose in the 1,000 square miles that he surveyed in the summer of 1950.

Pete Sovalik quoted his grandfather as having told him that he did not recall having seen a moose while he (the grandfather) was a child living near the mouth of the Colville River. Moose appeared later. Pete's father remembers moose as uncommon when he (Pete's father) was a child also then living and hunting near the mouth of the Colville River. In the life time of Pete Sovalik the moose have increased and now are common in the lower reaches of the Colville River.

According to Sovalik, moose browse in a canyon or valley until they have exhausted the supply of willows and then abandon the area until after the willows have recovered.

In an oxbow near Gavia Lake in the afternoon of August 19, 1952, when ice was forming and a light snow was falling, a moose fed in the water half submerged. The temperature that night at midnight was 24° F.

According to Frank Spinning, two moose, 20 miles down-river from Gubic, in December, 1951, had locked their antlers together.

These moose supplied food for two wolverines for part of the winter. Communication poles at Gubic and Umiat were repeatedly pushed over by moose according to Spinning.

Records of occurrence.—Specimens examined, none.

Records (unless otherwise indicated from James W. Bee, MS, 8 September 1952): (1) mouth of Kuparuk River on Arctic Ocean, 148°07′00″, 70°23′50″ (killed by Pete Sovalik on September 1, 1931); (2) salt water flats at mouth of Fish Creek, 151°20′00″, 70°22′20″ (calfless female seen by Harmon Helmericks in August 1951); (3) Colville River, 150°50′00″, 70°19′30″ (seen by Harmon Helmericks on August 14, 1952); (4) Colville River, 150°52′, 70°18′ (seen by Joash Tukle 1935); (5) Colville River, 151°13′00″, 70°03′30″ (seen by Joash Tukle on June 30, 1951); (6) Colville River, 151°40′, 69°59′ (tracks noted by Pete Sovalik in 1924); (7) West Kuparuk River, 149°37′00″, 69°51′30″ (five in one group seen by Pete Sovalik in 1942); (8) Canning River, 146°16′00″, 69°37′30″ (area of greatest congregation of moose on the Arctic Slope as determined by Pete Sovalik in 1942); (9) Gavia Lake, 150°00′, 69°35′, 460 ft., N White Hills (seen by James W. Bee on August 19, 1952); (10) Canning River, 146°23′, 69°35′ (seen by James W. Bee on July 22, 1952); (11) East Fork Shaviovik, 146°41′, 69°34′ (area of heavy congregation in 1942 as determined by Pete Sovalik); (12) Sagavanirktok River, 148°30′00″, 69°27′30″ (killed by Pete Sovalik in 1929); (13) east of Lake Schrader, 145°08′00″, 69°24′30″ (tracks and fecal pellets seen by Marvin Mangus, *fide* J. W. Bee, 23 July 1952; Leopold and Darling, 1953:87); (14) Umiat (seen by Charles W. Whittington in 1946); (15) [definite localities unspecified]: "occasionally it appears to leave the shelter of the forest to wander to the shores of the Arctic Ocean (Lydekker, 1901:50); Colville [River] (A. J. Stone, 1900:49); (16) Maybe Creek, 154°36′00″, 69°21′40″ (seen by Charles W. Whittington in July 1949); (17) West Kuparuk River, 150°15′00″, 69°17′30″ (10 to 15 seen by Pete Sovalik in 1942); (18) Sagavanirktok River, 148°04′, 69°17′ (killed by Pete Sovalik in 1936); (19) Anaktuvuk-Colville rivers [where on the rivers unspecified] (seen by Harmon Helmericks between Anaktuvuk Pass and the mouth of the Colville); (20) Colville River from Umiat to 100 miles west (averaging one every air-line mile along river in 1950 according to Ralph Steiner); (21) Awuna River, 155°32′, 69°02′ (seen by Charles W.

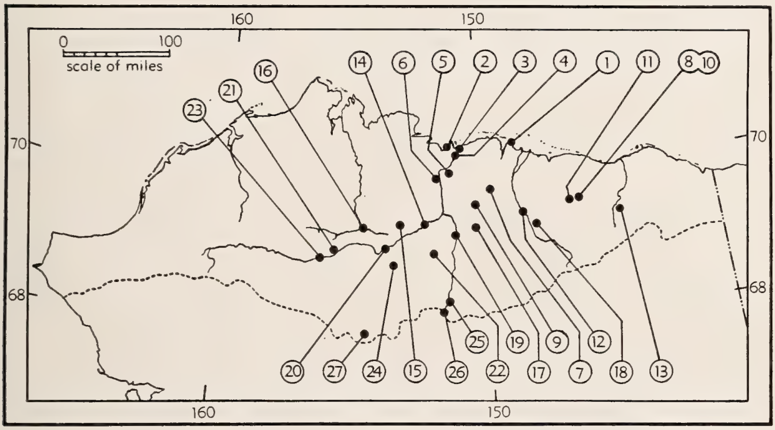


FIG. 114. Record stations of occurrence for *Alces alces gigas.*

Whittington on July 10, 1952); (22) Grandstand, 151°59′, 68°58′ (seen by William L. Wyatte—*fide* J. W. Bee, MS, 27 June 1952); (23) 100 mi. W Umiat on Colville River (seen by Ralph Steiner in 1950); (24) Killik River, 153°02′ 00″, 68°18′20″ (seen by Charles W. Whittington in 1945); (25) just south of Tulugak Lake (Rausch, 1950c:466); (26) Anaktuvuk Pass (Rausch, 1951: 186); (27) head waters of Colville (A. J. Stone, 1903:294).

Rangifer arcticus stonei J. A. Allen

Barren-ground Caribou (Tutupiak)

Rangifer stonei J. A. Allen, Bull. Amer. Mus. Nat. Hist., 14:143, May 28, 1901, type from Kenai Peninsula, Alaska.

Cervus tarandus, Harlan, Fauna Borealis, Philadelphia, p. 232, 1825.

Rangifer tarandus groenlandicus, Murdock *in* Expedition to Point Barrow, Alaska, by P. H. Ray. Exec. Doc. No. 44 (48th Congress, 2nd Session), p. 98, 1885.

Rangifer tarandus caribou, Nelson and True *in* Arctic series of publs. No. 3, issued in connection with the U. S. Signal Corps, U. S. Army by Nelson, p. 233, 1887.

Rangifer tarandus arcticus, Lydekker, The deer of all lands, Cervidae living and extinct, London, p. 47, 1898.

Rangifer arcticus, W. Stone, Proc. Acad. Sci. Philadelphia, Pt. 1, p. 34, March 24, 1900. (Also Elliot, 1901:37; Stone and Cram, 1905:52; Dugmore, 1913:139; Anderson *in* Stefansson, 1913b:502; Bailey and Hendee, 1926:21.)

Rangifer excelsifrons Hollister, Smithsonian Misc. Coll., 56(35):5, February 7, 1912, type from Meade River, near Point Barrow, Alaska. Regarded by O. J. Murie, N. Amer. Fauna, 54:76, August 8, 1935, as inseparable from *Rangifer arcticus stonei.*

Rangifer tarandus excelsifrons, Lydekker, Brit. Mus. Nat. Hist., 4:253, 1915.

Rangifer arcticus excelsifrons, Jacobi, zool. Anz., abt. f. Syst., 96:84, 1931. (Also Anderson, 1934b:4071.)

Rangifer arcticus stonei, O. J. Murie, N. Amer. Fauna, 54:76, August 8, 1935. (Also Dixon, 1938:199; G. M. Allen, 1942:301; Rausch, 1950c:466; 1951:186.)

Rangifer tarandus stonei, Rausch, Arctic, 6:139, prior to October, 1953.

Description.—Heavily built deer; 4 to 4½ feet high at shoulder; muzzle wide and hairy; antlers semipalmate, present in both sexes; browtine large and laterally compressed; hooves large and broad; dewclaws almost touching ground; tarsal but no metatarsal glands; pelage brown; end of muzzle, tail, rump and area above each foot whitish yellow; underside of neck having long well-developed white fringe extending over neck onto sides; hair shaggy, longer in winter than in summer.

Cranial measurements as recorded by Hollister (1912:5), of the holotype of *R. excelsifrons* from Meade River, near Point Barrow are: condylobasal length, 366; basal length, 344; palatal length, 230; postpalatal length, 144; greatest breadth, 175; greatest length of nasals, 119; maxillary tooth-row, crowns, 92.5; mandibular tooth-row, 96; upper molars, 52; upper premolars, 43; lower molars, 57.1; lower premolars, 42. Measurements of a fragment of the skull of an adult (51984) from the Birnirk Mounds (Birnirk Culture), deposited 1,000 years or more ago, are: maxillary tooth-row, crowns, 93.7; upper molars, 51.0; upper premolars, 42.7; width second upper molar, crown, 13.4.

A set of antlers from Umiat measured from uppermost tip of antler to outer-most tip of browtine, 1226 mm; from basal attachment to uppermost tip of antler, 850 mm; greatest spread, 750 mm.

Remarks.—We employ the name *Rangifer a. stonei* tentatively. Eskimos state that caribou on the Arctic Slope are paler than those south of the Brooks Range in spite of the fact that caribou of the Arctic Slope move between the two areas.

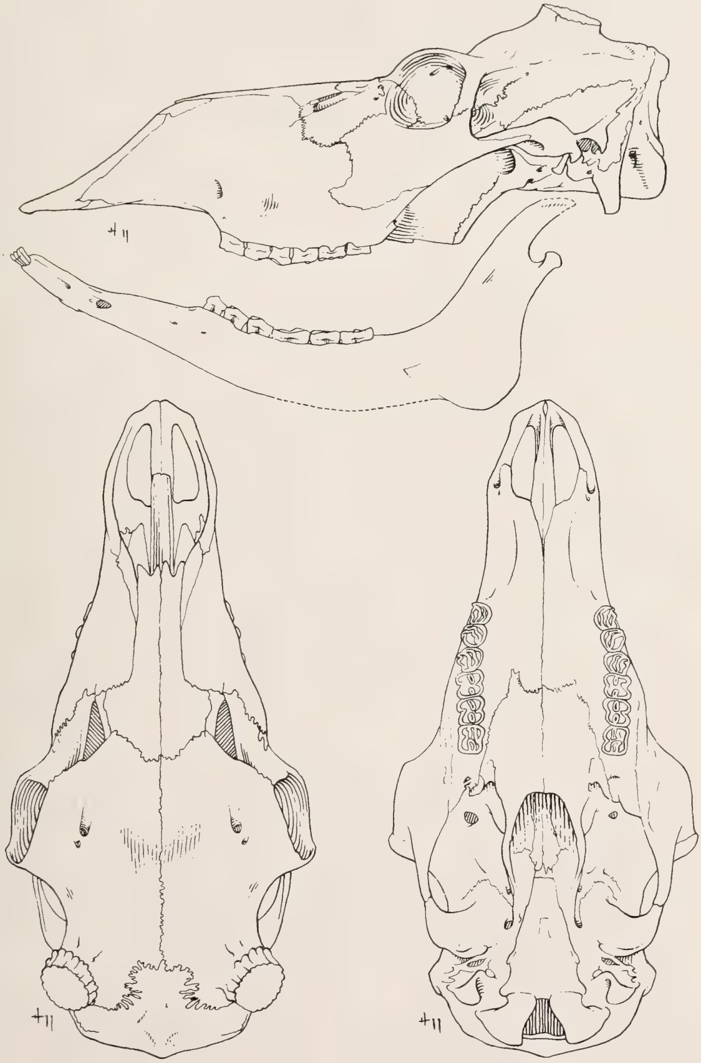


FIG. 115. Skull of *Rangifer arcticus* [subspecies *groenlandicus* (Gmelin)], Holsteinberg, Greenland, 1895, No. 2266 KU, sex ? × ¼.

The introduced reindeer, *Rangifer tarandus,* has been herded at various points along the Arctic Coast since the turn of the century, and has repeatedly hybridized with the caribou. From caribou, reindeer usually can be distinguished by shorter legs and rounded (anteriorly less pointed) hooves. The hybrids frequently are mottled black and white or entirely white.

Caribou occur on all parts of the Arctic Slope. Eskimos of the present generation who have hunted on the Coastal Plain and in the Plateau Province say that there are fewer caribou there today than there were before the influence of the white man was felt and that only recently have the caribou shown a tendency to increase. They believed that the decrease of caribou resulted from white man's interference on the winter range south of the Brooks Range of mountains, and from the overgrazing of the vegetation and competition by reindeer on the north side of the Brooks Range, and from competition otherwise, there, with reindeer. Competition with the reindeer has forced the caribou to withdraw from a part of the summer range.

Overgrazing may be the basic cause of the decrease of caribou, but killing by man also has been an important factor just as it was for the muskox which was killed out after the appearance of the white man and the rifle, before the vegetation was changed by overgrazing.

The decline of the Eskimo population has reduced hunting pressure on the caribou but the availability of guns and ammunition has offset the effect of the smaller number of hunters. Localization of Eskimos, who live in fewer villages than formerly on the Arctic Slope, has resulted in heavy hunting pressure in the immediate vicinity of villages.

Overgrazing by reindeer reduced the available winter food during the earlier period of the reindeer industry but now the normal plant succession, particularly in coastal areas, offers an increasing supply of willows which seem to have partly replaced the original vegetation. Robert Williams, an Eskimo at present (1951) living at Bettles, stated that caribou were common 15 years ago in the Bettles area but that today only five or six animals were seen in a year. He is of the opinion that there has been a reduction in numbers rather than a change in migration pattern in his area which is south of the crest of the Brooks Range.

Bones taken from the Birnirk Mounds show that the caribou were present in the Point Barrow area more than a thousand years ago.

Employees of the United States Fish and Wildlife Service made extensive and intensive efforts to kill wolves in northern Alaska—presumably to benefit the caribou—and the destruction of the wolves was the subject of much discussion among the native people in 1951 and 1952. Having in mind the efforts of the United States Fish and Wildlife Service directed against wolves and also toward the destruction of carnivorous mammals in other parts of Alaska,

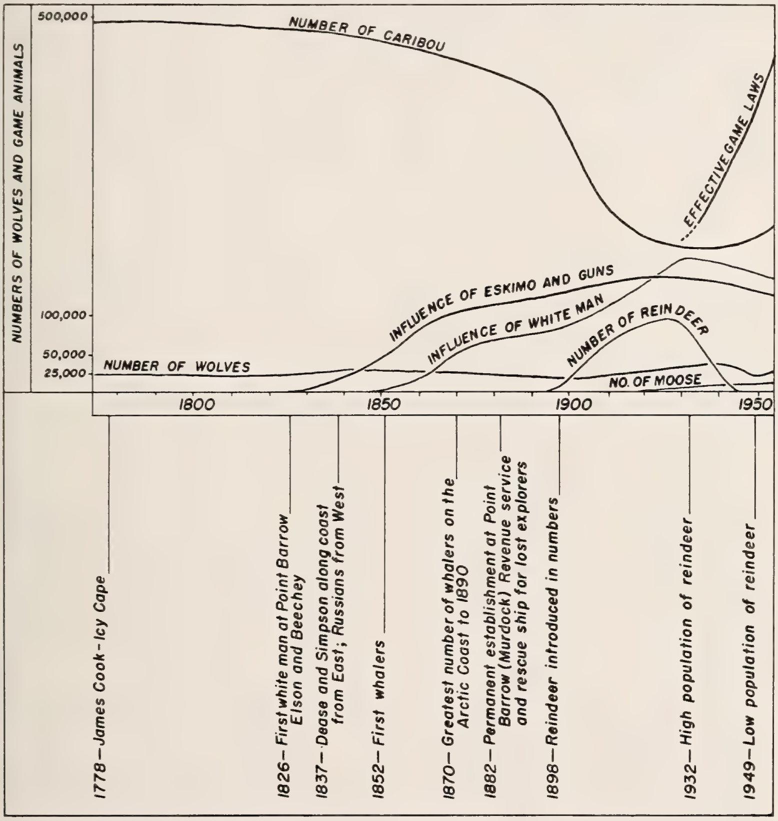


Fig. 116. Diagram suggesting causes for decreases and increases of caribou, on the Arctic Slope. According to many of the Eskimos living now (1952) at Barrow Village, man has been responsible, directly or indirectly, for the fluctuation in numbers of caribou. Caribou will continue to increase in proportion to the quantity and quality of the forage on the range and the effectiveness of game laws.

one of us (Hall) on November 28, 1952, wrote to Albert Day, then Chief of the United States Fish and Wildlife Service, as follows:

> "For each of several consecutive years now, at least one field zoologist from this institution has made studies in Alaska. Inevitably these men encountered the "predatory animal control" of the U. S. Fish and Wildlife Service.
>
> "There has been considerable criticism, as you know, of the recently inaugurated destruction of flesh-eating animals in Alaska by officially assigned personnel of the U. S. F. & W. Critics have made, among others, the following points: Such control as may be desirable in certain areas at certain times already is accomplished by private hunters and trappers; using poison and shooting from aeroplanes are especially objectionable means of "control"; "control" may be harmful to the fauna; "control" is expensive and a waste of tax monies.
>
> "In considering the matter, I concluded that if our positions were reversed I would welcome an expression of opinion from you. Therefore, I venture to point out that our field biologists think there is basis for the criticisms. On the Arctic slope of Alaska this past summer, I, myself, noted evidence that the caribou herds are on the increase. If the increase should continue to the point of overpopulation, then the killing of their natural enemies, the wolves, by the Fish and Wildlife Service will be widely cited (even if incorrectly) as the cause. Anyhow, to continue killing wolves seems pointless. Indeed, the evidence that we have indicates that the expenditure of public monies for destruction of flesh-eating mammals under present conditions in Alaska is unjustified. Might it be discontinued there?"

Darling, who visited northern Alaska in 1952 under the auspices of the New York Zoological Society, independently writes (1954: 281):

> "The present strength of caribou in Alaska is in the Arctic third of the country, and it is our opinion that the herds have increased there [and *op.cit.*:282]. . . .Regeneration of range in arctic Alaska is very slow indeed, and the greatest danger there is lest the game population should so far increase as to overgraze the range. The re-growth of the lichen would be so slow that overgrazing would have immediate effects in producing starvation and a crash of the herds. That would be a calamity. . . .But take a vast area of cold country, where man can neither farm nor be a rancher, and where he cannot subsist in any considerable numbers, it may well be then that the wolf is not only the guardian of the range, but the guardian of the wild herds as well. He helps to keep them on the move and prevent them increasing to numbers too great for the range."

The caribou is adapted to a relatively flat or gently rolling topography, although this animal is capable of negotiating steep and rugged terrain also. In the mountains, travel is along routes of least resistance whereas on lowland tundra the grazing caribou are common on elevated ridges between marshes and lakes. Frequently there is a single trail at the contact between the tundra and the grasses and sedges around lakes and marshes. If the bottom of a lake is solid, caribou use a trail in the water along the edge of the lake. Trails occur in marshy areas, but not so frequently as on well-drained ridges. For rapid travel, sandy beaches of large lakes are preferred to tundra. Sandy deltas of rivers that enter the Arctic Ocean are extensively used for travel and resting.

The deeper waters of lakes and rivers are crossed by caribou, usually at the narrowest places. Herds tend to build up there. Sometimes, however, for no apparent reason caribou enter the water and swim across the widest part of a lake.

The largest concentrations of trails are at the contact of the Coastal Plain with the Plateau. This plateau provides topography optimum for caribou. In the Brooks Range, caribou are common in east-west intermontane valleys and in low north to south canyons; the latter are used as migration thoroughfares. Although the more gentle slopes of mountains are used, caribou occasionally occur in almost every conceivable situation from high ridges flanked by precipitous slopes, to rock fields, moraines and rocky or sandy river bottoms. The tundra floor of a canyon is preferred to a rocky stream bed or ephemeral stream course. Main trails in canyons pass around obstacles, although caribou have been seen to jump down into a sandy stream-bed from a bank three meters high. Others climbed directly up a boulder field at gravitational repose. Low passes are generally approached or descended at a grade.

Caribou seem to be able to cope with all the varied climates of the Arctic. Low temperatures are less incapacitating than an unfavorable surface on snow. A crusted snow, which generally forms along the coast, forces caribou inland to areas of powdered snow. In winter, wind-swept ridges and other places where there is but little snow are said to be preferred.

The caribou lives in plant associations consisting of mosses, lichens, sedges and especially grasses. In late autumn and winter the main food is lichens. In summer when lichens are dry other plants such as grasses, sedges and browse are utilized.

Being a major influent animal, the caribou comes into contact with nearly all of the different kinds of mammals on the Arctic

Slope. Its closest association is with the wolf which follows the herds of caribou.

The relation of the caribou to its plant community and *vice versa* may be more important than anything else in the economy and perpetuation of the caribou on the Arctic Slope. The increase or decrease of caribou, outside of natural cyclic fluctuation, usually is directly correlated with abundance or scarcity of food plants. Of the food plants, lichens and grasses are perhaps most important to caribou and any change in the succession of the lichens and grasses or the introduction of a new competitor which becomes better adapted to the vegetation of the changing succession temporarily reduces the numbers of caribou.

A pronounced coaction on grasses and sedges is the result of trampling and the making of trails, especially on the floors of canyons, where the meadows of grasses and sedges are so trampled that only a lane of mud remains (see plate 4, fig. 1). If the plants are not completely destroyed, they are flattened—their tops point in the direction that the herd moved. The well-developed clumps of cotton-grass (a sedge) withstand complete destruction better than other plants and sometimes remain where other plants disappear in areas so trampled that the mud is 300 millimeters or so deep. Trampling is most intense wherever a lane of travel is narrowed, as for example where the hills encroach on a canyon floor. Outside of canyons a herd of caribou spreads out and the hooves produce a furrow effect; individual trails are separated by a foot or so of untrampled vegetation. For example, in Ignek Valley, in 1952, the number of parallel trails varied from five to 88 depending on the width of the area suitable for travel. At Chandler Lake there were 70 parallel trails in a meadow 50 meters wide. Trails on sand, after a herd of caribou had passed, averaged about one meter apart. During rains the intervening ridges of vegetation offer refuge to small mammals; the trails are filled with water. In the mountains the vegetation not in the migrating lanes made by caribou is unaffected except by an occasional animal or during periods when herds paused to rest or graze. Within lanes of travel there are areas of plants untouched by caribou; these areas are protected by lateral moraines, loops of meandering streams, large rocks, mounds and other physical features. Areas of plants that have been protected in this way for many consecutive years are conspicuous because of the ranker plant growth there, especially grasses. Possibly caribou are in part responsible for the stage of succession and shape (growth form) of individual plants that are present.

Willows along the line of migration are trampled or repeatedly defoliated, some to an extent that kills them (see plate 4, fig. 2). Low willows are less affected than those from two-thirds of a a meter to one meter in height; caribou prefer the higher willows for browsing. Willows only a few feet away from lanes of travel are untouched while those in the lanes are usually eaten. Some willow branches are broken off only with considerable exertion judging by the frayed ends. Repeated trampling prostrates willows; some runners extend horizontally as far as four meters and only a few centimeters above the ground. Other willows are trampled to shreads or have the part of the branch that is directly in the trail completely defoliated and most of the bark removed. Many willows show effects of having been used by caribou in removing velvet from their antlers. Lichens and mosses that grow on rocks in lanes of migration are completely eliminated.

Flies and mosquitos cause caribou great discomfort and at times cause fatigue, nervousness, decrease in weight, and even disease—for example from the eggs of the warbly fly. In summer, caribou almost continually adjust their positions in the herd in attempts to rid themselves of insect pests. These insects seem to build up in numbers in a stationary herd. On some days the herds even break up seemingly as a result of attacks from insects. The warble fly will make a caribou run for a mile or so without stopping. When the caribou does stop running it usually stands motionless and places its nose near the ground in an attempt to prevent the fly from entering the nostrils. After shaking its entire body and listening again, the caribou will either remain to graze or, if the fly is still present, jump forward, shake the antlers and resume the running. A caribou, at such a time pants heavily, with open mouth and extended tongue, and a lone caribou seems to join a herd in order to throw off the fly to other animals. When a man is in the straight-line course of flight of a warble fly, the fly stops and buzzes two or three times directly above the man's head before continuing on its flight. These flies tend to follow the moving herds. Mosquitoes annoy caribou but it is doubtful whether the mosquitoes are responsible for seasonal migrations of caribou as has been claimed.

The wolf occasionally preys on healthy caribou, but usually eats those that are weakened or those that have died from injury or natural causes. In the wake of a herd of approximately 23,000 caribou that passed through eight miles of Carnivore Canyon south of Lake Peters (August 8, 1952) we found, dead, three young caribou and four old adults. The three young were on relatively flat alluvial fans where the herd had paused to rest. The four old adults were on rugged terrain; one extremely old individual was at the base of a precipitous terminal rock moraine and probably had fallen from the rocky trail that led down this slope. Wolves had fed on all seven carcasses. Tracks of wolves nearly always are associated with caribou tracks. The method used by wolves to kill a caribou is described in the account of the wolf on page 174. Eskimos say that three or four wolves can dispose of a medium-sized caribou overnight. We saw disarticulated limbs of one caribou carcass and supposed that several wolves fed on it at one time. The head usually is eaten last.

Eskimos report that occasionally a bear kills a caribou. On July 28 at James Robert Lake, feces of bear contained hair and bone-fragments of caribou. Within 15 meters of one carcass we found piles of bear feces of various degrees of freshness suggesting that one or more bears had repeatedly eaten from the carcass.

In canyon mouths on the north side of the Brooks Range, caribou in summer intensively graze on range where Dall sheep graze in winter.

Caribou and moose share the riparian association. On the side of the valley at Umiat in the summer of 1951 there was approximately one caribou dropping per 10 square meters. On the dry elevations in the marsh there was one per four square meters. Some of these droppings were only a few weeks old.

Small rodents and their food supply are locally devastated by trampling of caribou, especially in herds, as explained in the account of the singing vole on page 144.

When surprised, a caribou first snorts and then dashes away for approximately 30 meters and stops briefly. On each of two occasions when we approached resting caribou they ran short distances in two or three different directions before dashing away in a straight line. In running across the tundra they cross over hummocks, mounds, and shallow lakes without much deviation.

In a group of approximately 500 caribou north of Teshekpuk Lake on July 31, 1952, there were eight young of the year about one-half the height of the parents. One of the youngest remained about 100 meters behind the main group. It and the other young were unable to keep up with the herd; young probably are the first to be separated from a herd by wolves. In this group of 500 caribou only three of the adults were without antlers.

Pete Sovalik states that Eskimos use the large stomach of the caribou to hold oil and grease which is extracted from the bones of caribou and other animals. According to him the Eskimo who does not add fats and oils to his diet of lean meat becomes ill in 3 or 4 days; the person has chest pains and symptoms of grip.

Thomas Brower says that caribou defend themselves better from wolves than domestic reindeer do because reindeer are conditioned to dogs which are used in herding and therefore allow wolves to approach closely. He states also that hybrids between caribou and reindeer are wilder than either of the parents. He reported the loss in the late summer of 1952 of a herd of reindeer near Pitt Point. His herder had kept the reindeer in a closed group for the last 11 months and had them on a peninsula bordering the ocean. The herd stampeded and escaped when a herd of caribou passed; presumably the reindeer mixed with the wild caribou to the south since he was unable to find the reindeer again.

Golden eagles, generally distributed over the Plateau and Brooks Range, were seen feeding on carcasses of caribou on several occasion. One eagle fed on a caribou on the east side of Lake Schrader, and two eagles were seen feeding an a dead caribou on the east shore of Lake Peters. Approximately seven miles south of Lake Peters six ravens were picking shreads of flesh from between the vertebrae of a caribou that had been killed eight days before. A pigeon hawk was annoying the ravens.

In almost every sizable herd of caribou a few animals have injured legs. Others cough with every breath as though suffering from a respiratory infection or parasitic fly-larvae in the nose. We observed one old male that entered a boggy area of warm muddy soils and spent an hour repeatedly lying down for approximately five minutes and then standing for approximately a minute. Between each of these 'mud baths' he walked two meters or so.

Between August 15 and September 1, 1950, in the Carbon Creek area, Charles Whittington saw five caribou that had died from a hoof disease.

Eskimos claim that a caribou will die overnight from overexertion and overheating if caught by the foot in a trap.

Wherever caribou move—on tundra, talus, or top of a ridge—they greatly influence the physical features. The effects of trampling are especially noticeable. At Lake Peters, in one lane 200 meters wide down which 6000 caribou migrated, no area of soil so large as four inches square had escaped disturbance by the hooves of caribou. In other lanes, used by large herds, the ground surface resembled a newly furrowed field; the "furrows" ranged from superficial disturbances of the soils to ruts one and a half meters deep. On wet soils, especially where lanes of travel converged, as for example at a narrow place in a canyon, soils become knee-deep mud. Many caribou walking in wet soil on a slope convert it into a modified solifluction terrace. In some places there were one or two deep trails frequently used by small groups of caribou. When a large herd of caribou stops to rest, the animals scatter and occupy almost every conceivable situation on the canyon floor and hillside.

As a result of trails made by caribou, drainage of certain areas is changed. Horizontal trails retain water which in turn creates a hydrosere on the slope that otherwise would be a dry hillside. If trails are at a grade, runoff is hastened and a dry meadow results. Trails across steep shaly slopes tend to work loose material down hill.

Hooves of caribou that follow trails across rock fields or solid rock scour the rock and reveal its intrinsic color. Trails are also made and maintained across rocky and sandy creeks and river bottoms.

Shore lines of lakes especially steep banks, are repeatedly broken down by caribou. Deep gullies form where caribou leave the beach to reach the tundra and also on banks of rivers where caribou cross. In early summer when fording fast moving creeks and rivers, caribou lose large quantities of hair. This collects in windrows, some a meter high, at the edges of rivers and lakes, thus adding to the composition of the soil.

Fecal droppings of caribou fertilize soils. In a transect one meter wide and 1000 meters long immediately north of Teshekpuk Lake we found 202 piles of droppings and there were additionally many deposits of a single pellet in a place.

Between lowland lakes there, trails were as much as half a meter deep.

Migration

Originally, caribou probably made true migrations but today they seem to wander erratically. In the Driftwood area, according to Charles Hummel, caribou remain on the flat tundra during June and July and move into the mountains in August. He believes that caribou follow well defined trails but that trial and error guides them through passes in the Brooks Range; in other words, caribou do not use the same pass every year.

According to Harmon Helmericks, who has flown considerably over the low Coastal Plain: Caribou summer along the coast or along larger bodies of water inland. In winter, when ice forms on top of the snow along the coast, caribou move back to a zone between the ocean and the Plateau Province where snow is powdery and ridges are exposed. Movements in both summer and winter parallel the coast and are not from north to south. There are no main herds in northern Alaska but groups of caribou are continually breaking up and reforming into smaller or larger groups. In 1947 a caribou herd moved up Schrader Lake Canyon from flats to the north of the lake, probably from Shubik Valley or the head of the Sadlerochit River. In mid-August caribou segregate into separate groups: adult bulls, cows, 2-year olds, and 3-year olds.

Lew Shawan, a bush pilot in northern Alaska, had observed a somewhat different pattern. He thinks that: On the Arctic Slope there are large herds each of which retains its idenity from year to year, not moving far and remaining in both summer and winter in the same general area; herds on the south side of the Brooks Range are distinct and do not mix with those on the north side of the Range especially those in the western segment of the range; herds in the eastern part of Alaska, according to Shawan, enter Canada in winter.

At Topagaruk on July 5 we observed recently made caribou trails in sand dunes along the edge of the river and also at one or two points in the climax tundra. Four caribou killed by Eskimos at this camp in the previous week presumably were those that made the tracks as no others or fresh sign were seen. Old sign occurred in the area; on the average there was some trace of the former occurrence of caribou in approximately every 1000 square meters. We were told that the caribou which spend the summer here had not arrived from the south.

On July 20, 1951, to check the numbers of caribou, we flew approximately 30 feet above the ground from Point Barrow to Kaolak. Only two caribou were seen. There were few animals on the low Coastal Plain. On July 27, 1951, on the return trip, by air, from Kaolak to Point Barrow we saw three single caribou along the same route. At Kaolak we were told that caribou came into this area on about August 4 after the mosquitos disappeared. On

July 25, 1951, a group of 15 and two singles were observed at Kaolak.

At Chandler Lake on August 10, 1951, we observed two singles and one antlerless female with a young one about ½ the height of the adult. One of the singles was moving north and the other south.

At Gavia Lake on August 22, 1952, we found many trails all made in former years. Tracks showed that eight caribou had passed from west to east in the last week and that one moved from east to west.

On August 16 we made a census of caribou from the mouth of the Canning River (at the front of the Brooks Range) to a point 80 miles directly west. Caribou averaged one in every two miles. Most of these animals were singles and pairs. They were grazing. No large herd was seen.

On August 27, 1952, we flew on a direct line from Point Barrow to Driftwood. Immediately before reaching the Plateau Province we observed many parallel trails each about one meter from the next. There was no evidence of movement of caribou between this area (of trails) and Point Barrow, or to the north but the trails were common to the south. Most of the trails trended from NW to SE while older trails trended from SW to NE. The caribou, in groups of one to four (47 by actual count from one side of the airplane) were generally distributed south of the contact and in every instance were headed, and generally were moving, south. On August 29, 1952, at Driftwood, we observed five single caribou all moving southward.

In the autumn of 1951 Joash Tukle reported caribou migrating for the first time in many years near the coal mines on the Meade River. He reported also that caribou arrive on the coast (mouth of the Colville) on July 1 and leave about August 10. According to him they come for the cool weather, which the Arctic Ocean affords in summer. In winter nearly all of the caribou which spend the summer near the mouth of the Colville River, move back to a place about 26 miles north of Umiat. Thomas Cade and George Schaeller reported caribou to be numerous along the Colville River between Etiviluk and Umiat from July 20 to July 29, 1952.

Charles W. Whittington noted that on the Awuna River caribou started to the south on about August 5, 1949, and continued leaving until the end of the month. There were no caribou in this area before or after these dates.

Helmericks said that there are approximately 15,000 caribou on the East Fork of the Shaviovik River every summer. He reported also 20,000 caribou in one herd in March, 1946, on the East Kuparuk River.

On July 3, 1952, while flying into Wahoo Lake from Umiat, we saw old and new caribou trails trending mainly westward and eastward west of the Sagavanirktok River whereas trails immediately east of Umiat ran north and south. On July 22, 1952, while on a flight from Umiat to the mouth of the Canning River at the front of the Brooks Range, thence to near Barter Island and return, we saw no caribou, but at a later date observed many along this same route.

In the low pass in which Wahoo Lake is situated trails were numerous, indicating movement of caribou in the system of east to west canyons within this part of the Brooks Range.

In the Porcupine Lake area on July 17, 1952, caribou were on slopes supporting the least vegetation, especially the talus and Sadlerochit shales.

On July 29, 1952, caribou were numerous between Smith Bay and Teshekpuk Lake; one group of approximately 150, including 8 white animals, was at the west edge of the lake. The parts of sandy beaches immediately adjacent to tundra were almost covered by tracks. This habit of collecting in herds at the edges of large lakes before moving across or around them may account for the fluctuations in number of caribou at certain places.

Harry S. Newman, stationed at Umiat, reported that caribou moved into the Brooks Range in October where they remain all winter on wind blown ridges. By mid-May they migrate back to the low tundra for the summer. Along the coast, caribou move parallel to the ocean. He saw 15 east of Fish Creek Camp in early September of 1950. In spring when caribou calve they remain in small groups in localized areas.

On September 12, 1952, after snow covered the ground, we saw no caribou between Umiat and the Brooks Range.

Our observations (33 or more) of caribou on the Arctic Slope enable us to say that: 1) Caribou are on the Coastal Plain as early as June 1 and as late as September 1; 2) Caribou are present on the Plateau Province from July through August; 3) in the Brooks Range they are present from the middle of July to the first of August. Published accounts and reports of other persons make it clear that caribou have been seen in every month of the year in all three provinces of the Arctic Slope.

Stoney (1899:818) writes that when he traveled [middle of May, 1886] down the Chipp [Ikpikpuk] River the country became more open, the hills lower, and game [caribou] scarce as the herds scattered over the open country and around lakes instead of remaining along rivers. He (1899:837-8) wrote also that caribou were all through the country [presumably in the summer], but were especially numerous in the mountains at the headwaters of the Colville River. The statement by Stoney (1899:570) that the Eskimos at Issheyuk [at Howard Pass] would not escort him to Point Barrow in the middle of December because to go at such a time would result in starvation, suggest that caribou are not on the Arctic Slope in winter or at least are not plentiful enough to be killed for food in significant numbers.

The activity and composition of herds of caribou fluctuate from day to day. Observations made in late July and early August of 1951 at our camp approximately a mile north of Teshekpuk Lake are as follows:

> July 30: 105 caribou moving east; most of them descended onto the sandy beach at the north edge of Teskekpuk Lake and continued out of sight while a few remained on the higher tundra. On the beach the caribou traveled faster, and soon were three miles ahead of those on the tundra. A few of the latter then descended to the beach but were too far behind to regain their position with the advanced group. These caribou trotted most of the time. Later in the day four single adults passed, moving east also, along a submerged beach, in about four inches of water. Fresh tracks in the area showed that most of the travel was from west to east. The weather was foggy.
>
> July 31: In the morning, caribou were moving wildly in all directions, generally as individuals or small groups. There was a slight tendency for groups to build up during the day. In the afternoon approximately 500 caribou trotted from east to west. Several small groups were separated from the original herd of 500 caribou. At 6:00 p.m. 58 caribou stood in water up to their bellies about 30 meters from shore in Teshekpuk Lake. They faced the shore and remained half an hour, then walked to the upper tundra and grazed leisurely in loose groups. At 10:00 p.m. the caribou were generally distributed over the tundra and were quiet and resting. Forty-five single caribou could be seen at one moment. The sun disappeared below the horizon at about 11:30 p.m. but it was light all night. On this date it was hot in the morning which seemed to increase the activity of the flies.
>
> August 1: Single caribou moving at random at 1:00 p.m., some coming as close as five meters to our tent. Their main concern was the fly and they were repeatedly running with open mouths and were breathing rapidly. By nightfall most of the caribou had

> moved out of sight. Eight singles were observed at one moment as compared with 45 singles observed yesterday at one time. At 11:30 p.m. only five caribou were in sight; they were feeding in the marshy area to the east.
>
> August 2: Only two caribou on tundra today.
>
> August 3: No caribou in sight. Rains and high wind during the night.
>
> August 4: In the morning 12 caribou leisurely fed in the marshy area. About 10:00 a.m. 200 caribou arrived from the west and instead of following the usual route around the south end of the lake, they moved directly across the north end of the lake. We returned to Point Barrow on August 4. Enroute there, we counted three single caribou in the first 10 miles and five in the second 10 miles. No caribou were seen in the remaining 70 miles.

We camped in the Lake Schrader-Lake Peters area from July 23 to August 16 inclusive. In the three days before our arrival a large herd of caribou passed. Richard D. Olson, an employee of the U. S. Geological Survey, recorded in writing the movement of 7,000 of these caribou which had moved past the site of our camp on July 20. His account follows:

> "More than 1,000 caribou in a compact herd, its front accosting me with curiosity across the stream at 30 yards distance. They were mangy and of very drab color—a motley animal at this time of year—some were buff, dirty yellow, deep brown, but most were spotted and mangy, as the heavy winter's fur sluffs off, revealing a shorter, smoother new coat. They were grunting, snickering, puffing, coughing, wheezing, waggling and shaking their rumps, scratching with a hind leg or biting their sides. They ran fast one moment as if in escape or pursuit, then the next moment idled over a tuft of grass chewing and shaking and wiggling, biting and scratching. Many limped carrying a broken leg or damaged leg lamely, obviously unable to keep pace with the great migration for long. Most of them with but a pair of small horn-like antlers rising 6 or 8 inches over their thin flapping ears. Some with huge, tree-like branching growths of antlers—the size of rocking chairs. Many calves trotting and stumbling at the heels of the does.
>
> "I counted 5,000 in the space of 1½ hours while I sit quietly on the stream bank. They are passing along the opposite side of the canyon, then wheeling across the river 100 yards above me. But they are startled, then confused when I remove my jacket as the cloudy sky breaks open and the sun streams down. They mill uncertainly in one direction then another, but fear the crossing. Eventually they mill down the canyon until the front is but 30 yards from where I sit quietly. The stream continues to flow into this herd, 2,000 or more, I calculated, although

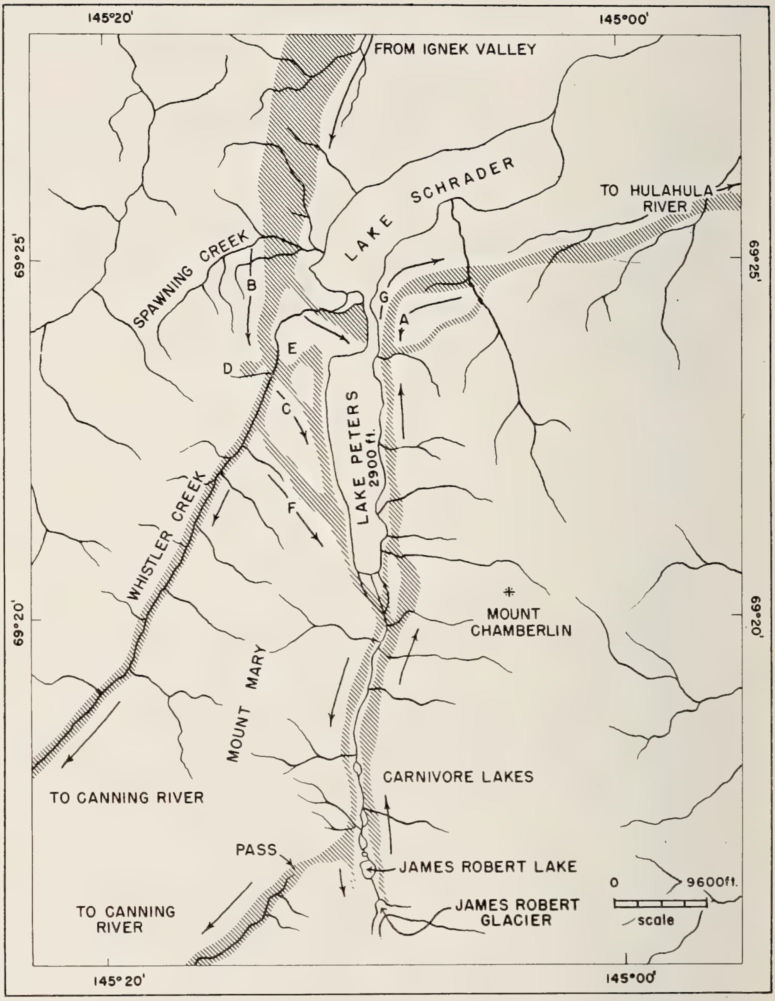

145°20'
145°00'
FROM IGNEK VALLEY
LAKE SCHRADER
TO HULAHULA RIVER
SPAWNING CREEK
69°25'
69°25'
B
G
A
E
D
C
LAKE PETERS
2900 ft.
F
WHISTLER CREEK
MOUNT CHAMBERLIN
69°20'
69°20'
MOUNT MARY
CARNIVORE LAKES
TO CANNING RIVER
PASS
JAMES ROBERT LAKE
0
9600ft.
scale
TO CANNING RIVER
JAMES ROBERT GLACIER
145°20'
145°00'

Fig. 117. Map of Lake Schrader-Lake Peters area showing travel of approximately 23,000 caribou from July 19, to July 22, 1952. (A) On July 19, at 11:00 p.m., caribou arrived from the Hulahula River and continually passed point (A) until 9:00 a.m. the following day. In one hour from 7:00 a.m. to 8:00 a.m. on July 20, 500 caribou were counted. On the basis of this count, it is estimated that 11,000 caribou passed in 22 hours. These animals continued up the canyon south of Lake Peters and after crossing the river they went over the pass west of Carnivore Lakes and continued down the drainage of the Canning River. (B) On July 20 a herd of caribou arrived from Ignek Valley. From 11:00 a.m., when the animals were first noticed, to 12:20 p.m., a count of 5,000 was made. The movement lasted until 1:30 p.m. The number that passed prior to 11:00 a.m. is not known. Of the 5,000 caribou, 3,000 continued

over the pass (C) and continued south along the west side of Lake Peters; 1,000 remained in area (D) and 2,000, including those which arrived after the count of 5,000 was made, moved over the ridge to area (E) where they remained for several hours before moving south up the canyon south of Lake Peters. Some of the animals which moved up Whistler Creek crossed over the high ridge at the base of Mount Mary (F) and dropped down to the edge of the south end of Lake Peters to continue south up the main canyon. Nearly all of the caribou from the Ignek Valley passed up either Whistler Creek (1,000) or the canyon south of Lake Peters (6,000) and over the pass into the drainage of the Canning River. Less than 100 forded the channel between the two lakes. (G) On July 21, caribou started passing by at 6:30 a.m. or earlier and continued in groups of from 2 to 100—always some were in view—to 7:30 p.m. that same day. A few were still passing on the morning of July 22. This herd of approximately 5,000 came down over James Robert Glacier and continued north along the east side of the canyon. In the lower part of the canyon they were using the same travel lanes as those used by the herd which moved up the canyon on July 19.

I have stopped counting now and am watching the caribou front, as it watches me, with curiosity only. Finally, the herd crosses the river. Others follow and the stream is once again in motion.

"Now they collect on my side of the river where there is less space. Their numbers increase but they still seem indecisive as to direction. Now they are only 20 paces away—immediately behind me—seemingly at ease, unconcerned by my presence—perhaps not aware of it now as they have become accustomed to my scent. They feed as they mill about, waiting for the whim of one or another to set the pace and the direction.

"Across the canyon I can see the deeply rutted streaks cutting diagonally down into the canyon from the higher open land beyond—ruts worn through the moss and grass by these animals prone to follow one behind the other.

"I finally stand, to see what the effect might be. The movement caused instant alarm among those at the forefront and the alarm spreads as quickly throughout the thousands and they swarm in front of me toward the new pass.

"I sit on the pass and watch them as they stand in continued idleness down the other side—the wind and tundra—affording them a luxury from which they were disinclined to despair even when I walked toward them.

"I could approach very near. The fringe of the herd balked and undulated, but the herd itself remained intact. I moved around them, rattled down the talus at the other side. They watched but did not move. They became more distant as I walked toward camp, leaving these beasts and the rest which it afforded after the long weary and as yet unended migration to an unknown direction and objective."

Other information which Olson supplied concerning the 23,000 caribou that passed our camp from July 19 to 21 is as follows:

About 1 in 20 was a large animal; most were of medium size. Seventy per cent lacked antlers or had very small antlers. One in 20 had antlers 8-10 inches long. Calves occurred in a frequency of one in about 15 and averaged less than three feet in height. They were capable of keeping up with the herd. Nearly all animals were mottled, some dark brown (generally the large ones) in contrast to the spotty light buff or gray. The herds that went into the valley moved faster than the herd which left the valley. No animals were at the lake level but on the hillside. They crossed streams by fours or fives which created a congestion behind and at the same point which generally included about a forty foot section of the river course. The weather for this period of active migration was as follows: July 19 cloudy and rain at night with wind from north; July 20 cloudy until 10:00 a.m. and again at night, warm and clear in afternoon; July 21 cloudy with intermittent rain; July 22 same as July 21; July 23 wind from west for first time (every other day from north); On July 18 and until the arrival of these animals there were no new migration trails in the area from the divide which connects a branch of the Canning River at the upper end of Lake Peters Canyon, down to Lake Schrader.

Single animals are graceful, alert and agile; as members of a herd or when weak from travel they react with less alertness. When the caribou is walking, its gait ordinarily is deliberate and the head is held below the line of the back and pointed slightly downward. The antlers are carried with the weight balanced perpendicularly. During a leisurely trot the legs are lifted high. When surprised, caribou turn abruptly and run fast for a short distance; the antlers are thrown backwards and seem to rest on the neck and back. The head is held above the line of the back and the nose points slightly upward. When a caribou runs rapidly the legs are spread wide apart. A herd of caribou moving across the tundra with antlers held high like poled effigies recalls to anyone who has lived in the Orient, a Chinese parade or funeral march.

Pete Sovalik believes that as soon as the sun appears above the horizon the rays from the sun turn the hair of the caribou a paler color. A pelt of a caribou from a winter-killed animal will change in spring but will change only once. The pelage is yellow, shaggy grayish-yellow, blackish brown, or white depending on the season.

Of several tracks measured at Lake Peters on July 28, 1952, the longest was 120 mm. The shortest was 50 mm. Nearly all of the imprints were pointed rather than rounded or blunt as is generally the case with older caribou. One young animal, which had been mostly eaten by wolves, was 900 mm in total length.

Records of occurrence.—Specimens examined, 2: Nos. 51984 and 51985, fragments of skulls from (2) Birnirk mounds, 156°36′02″, 71°20′40″, 8 ft., 2.

Additional records (from James W. Bee, MS, 8 September 1952 unless otherwise noted): (1) Point Barrow (Stone, 1900:34; Murdock *in* Ray, 1885:98; Nelson and True *in* Nelson, 1887:233; Anderson *in* Stefansson, 1913b:502; Anthony, 1928:531; Brower, 1942:96; Rausch, 1953:139); (3) Kuaru (Murdock *in* Ray, 1885:99); (4) Peard Bay (Rausch, 1953:139); (5) W side Smith Bay, 154°50′, 70°50′ (five seen by James W. Bee on August 4, 1951); (6) Smith Bay ("Countless herds of deer" were observed upon the flat shores of this bay on 27 July 1837 (Simpson, 1843:138); (7) Point McLeod [deep pound 4 miles inland from beach between Point McLeod and Point Drew] seen by Dease and Simpson, 1838: on map opposite page 224); (8) 9 mi. SW Cape Halkett (Dease and Simpson, 1838:217; near Cape Halkett, Anderson *in* Stefansson, 1913b:502); (9) N Teshekpuk Lake, 153°30′, 70°49′ (two seen by James W. Bee on August 4, 1951); Teshekpuk Lake [definite locality at lake unspecified] (Brower, 1942:167); (10) SE Smith Bay, 154°00′, 70°48′ (one seen by James W. Bee on July 29, 1951); (11) NW Teshekpuk Lake, 153°52′, 70°43′ (320 seen by James W. Bee on July 29, 1951); (12) 43 mi. S Point Barrow, Meade River (100 seen by Ira L. Wiggins on July 11, 1951); (13) Meade River near Point Barrow, 156°37′00″, 70°42′30″ (many seen by Joash Tukle throughout summer of 1951; Murdock *in* Ray, 1885:99; Miller, 1912b:392; 1924:492; Lydekker, 1915:253; Bailey and Hendee, 1926:21); (14) NE Teshekpuk Lake, 153°05′40″, 70°39′40″ (500 seen by James W. Bee on July 29, 1951); (15) Wainwright (Rausch, 1953:139); (16) Topagaruk, 155°48′, 70°34′, 10 ft. (tracks and animals seen by James W. Bee on July 5, 1951); (17) back of Wainwright (Bailey and Hendee, 1926:22); (18) Milne Point, 149°02′, 70°31′ (many seen by William Irving and Joash Tukle on July 5, 1952, moving west); (19) 6 mi. E Beechey Point, 148°53′, 70°29′ (seen by Harmon Helmericks in March 1946); (20) Kuparuk River Delta (Anderson *in* Stefansson (1913b:502); (21) delta of Colville River [150°57′, 70°28′] (groups of 12 to 50 and singles seen by Thomas Cade on July 18, 1952, singles in view at all times between July 17 and July 20; "tracks of caribou were numerous," (Schrader, 1904:23); Anderson *in* Stefansson, 1913b:502);

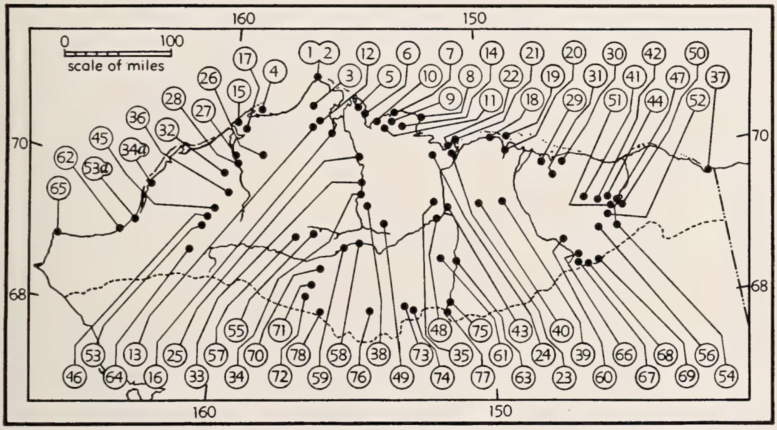


FIG. 118. Record stations of occurrence for *Rangifer arcticus stonei.*

(22) mouth Colville River, 151°14′, 70°25′ (several seen every day by William Irving and Joash Tukle, between July 5 and August 2, 1952); (23) mouth Colville River, 150°36′, 70°23′ (40 seen by Joash Tukle on July 13, 1952); (24) Fish Creek Camp, 152°00′00″, 70°18′40″ (1,500 seen by Harry S. Newman in early September of 1950—*fide* J. W. Bee, MS, 25 July 1951); (25) Ikpikpung River [definite locality unspecified] (Murdock *in* Ray, 1885: 99); (26) Nigiaktuvik River, 158°44′, 70°17′ (seen by James W. Bee on August 27, 1952); (27) Kaolak River, 159°47′, 70°13′ (killed by Atanak, an Eskimo from Wainwright—*fide* J. W. Bee, MS, 16 July 1951); (28) Kaolak River, 159°47′40″, 70°11′15″ (seen by James W. Bee on July 12, 1951); (29) Kadleroshilik River, 147°34′00″, 70°07′50″ (seen by Joash Tukle on July 1, 1952); (30) east of the mouth of Shaviovik River, 146°26′00″, 70°05′40″ (40 individuals seen by Joash Tukle on July 13, 1952); (31) East Fork Shaviovik River, 147°15′, 69°57′ (15,000 seen by Harmon Helmericks in July of every year at least since 1946); (32) Kaolak, 160°14′51″, 69°56′00″, 178 ft. (seen by James W. Bee on July 21, 1952); (33) [about 12 miles from Coastal Plain on Ikpikpuk River] "sited a few deer," on June [13], 1886, by Stoney (1899:819); 34 [about 50 miles down the Ikpikpuk River from Kig-a-lik] "killed 3 deer" on June 8, 1886, by Stoney (1899:818); (34a) in the vicinity of Point Lay (Brower, 1942:120); (35) 26 mi. N Umiat, 152°15′, 69°46′ (seen by Joash Tukle in 1952); (36) Kaolak River, 160°00′, 69°45′ (seen by James W. Bee on August 27, 1952); (37) Demarcation Point (Anderson *in* Stefansson, 1913b:502); (38) Wolf Creek Camp, 154°32′, 69°38′ (three or four groups of from 12 to 15 seen by William L. Wyatte on June 15, 1952 —*fide* J. W. Bee, MS, 28 July 1952); (39) East Kuparuk River, 149°15′00″, 69°37′30″ (20,000 in one group seen by Harmon Helmericks in March of 1946); (40) Gavia Lake, N White Hills, 150°00′, 69°35′, 460 ft. (seen by J. W. Bee, August 22, 1952); (41) mouth Ignek Valley, 146°05′, 69°34′ (new trails seen by James W. Bee on July 23, 1952); (42) Katakturuk River, 145°30′, 69°34′ (fresh trails seen by J. W. Bee on July 23, 1952); (43) mouth Anaktuvuk River, 151°27′, 69°33′ (20 seen by William Irving and Joash Tukle on July 25, 1952); (44) Sadlerochit River, 145°07′, 69°33′ (seen by J. W. Bee on July 23, 1952); (45) Carbon Creek, 160°30′, 69°30′ (5 seen by Charles W. Whittington on August 25, 1950); (46) Utukok River, 160°27′, 69°26′ (seen by James W. Bee on August 27, 1952); (47) N Lake Schrader, 145°04′, 69°24′ (trails noted by James W. Bee on July 23, 1952); (48) Umiat, 152°09′30″, 69°22′08″, 352 ft. (dead animal seen by Westley Redhead—*fide* J. W. Bee, MS, 2 July 1952) (49) [definite localities unspecified] Most northern regions in America (Harlan, 1825:235); barren districts lying to the northward of the forest zone in Arctic America, and extending to the Polar Sea (Lydekker, 1898a:48); barren grounds of Arctic America (Elliot, 1901:37; Stone and Cram, 1905:52); extreme north of America and Arctic Islands (Dugmore, 1913:139); Arctic Alaska (Anderson *in* Stefansson, 1913b: 502); Arctic Slope, from map (Anderson, 1934:4071; Burt and Grossenheider, 1952:160); Arctic Coast of North America (Dixon, 1938:199); Arctic Slope (G. M. Allen, 1942:302; Dufresne, 1946:32); (50) east of Lake Schrader, 144°54′, 69°22′ (seen by Marvin Mangus on July 23, 1952—*fide* J. W. Bee, MS, 23 July 1952); (51) mouth Whistler Canyon, 145°05′, 69°21′ (seen by Richard D. Olson, on July 20, 1952—*fide* J. W. Bee, MS, 23 July 1952); (52) Whistler Creek, 145°11′, 69°17′ (new trails seen by Marvin Mangus and J. T. Dutro on July 29, 1952—*fide* J. W. Bee, MS, 29 July 1952); (53) Utukok River, 160°42′, 69°15′ (seen by James W. Bee on August 27, 1952); (53a) between Point Lay and Corwin Bluff, about November 15 (Brower, 1942:20); (54) James Robert Glacier, 145°09′, 69°16′ (trails and dead animals seen by James W. Bee on August 8, 1952); (55) Awuna River, 156°25′00″, 69°13′ 30″ (seen by Charles W. Whittington on August 5, 1949); (56) Canning River, 145°10′00″, 69°10′30″ (new trails noted by Marvin Mangus on July 23, 1952); (57) Awuna River, 157°06′, 69°09′ (15 seen by Charles W. Whittington on July 2, 1952); (58) [12 mi.] down Colville River from Etivoli-par, "got six deer during the day", recorded on May 15, 1886, by

Stoney (1899:816); (59) [9 mi.] down Colville River from Etivoli-par, "herd of deer. . .shot 5" on May 14, 1886, by Stoney (1886:816); (60) Wahoo Lake, 146°58′, 69°08′, 2350 ft. (tracks noted by James W. Bee on July 12, 1952); (61) Chandler River, 151°48′, 68°56′ (new trails noted on September 12, 1952 by James W. Bee); (62) Cape Beaufort ("cloven-footed animals" seen by Beechey, 1831:370); (63) [between Anaktuvuk Pass and Colville River] ("many caribou were seen and one was shot" by Schrader, 1904:22); (64) Driftwood, Utukok River, 161°12′10″, 68°53′47″, 1200 ft. (seen by James W. Bee on August 27, 1952); (65) Cape Lisburne ("several reindeer" seen by Beechey, 1831:369); (66) Porcupine Lake, 146°29′50″, 68°51′57″, 3140 ft., Brooks Range (seen by James W. Bee on July 16, 1952); (67) Mount Annette, 146°28′51″, 68°50′38″, approximately 5700 ft., Brooks Range (seen by James W. Bee on July 17, 1952); (68) head Canning River, 146°19′00″, 68°50′04″ (seen by James W. Bee on July 17, 1952); (69) head Canning River, 146°25′00″, 68°49′40″ (seen by James W. Bee on July 17, 1952); (70) Tooloouk, in deep valley just off the Titivluk River ("a number were killed" and immense bundles of skins were seen on April 22, 1886, by Stoney, 1899:813); (71) [about 6 mi.] down the Etivluk River from Tooloouk ("deer" seen on May 1, 1886 by Stoney, 1899:813); (72) [22 mi.] down the Etivluk River from Tooloouk ("large head of deer", seen on May 2, 1886, by Stoney, 1899:814); (73) Okominilaga (Rausch, 1951:192); (74) Chandler Lake, 152°45′, 68°12′, 2900 ft. (seen by James W. Bee on August 10, 1951); (75) Tolugak [Tulugak] Lake (Rausch, 1950c:466; 1951:192); (76) Killik River [place on river unspecified] (Rausch, 1951:189, 192); (77) Anaktuvuk Pass region (Rausch, 1951:187); (78) within 3 mi. of Itivlik Lake and northwesterly along the Ahlasuruk River for approximately 8 miles (about 10,000 seen one day between June 19 and July 22, 1954, by Irving and Paneak, 1954:204).

Ovibos moschatus moschatus (Zimmermann)
Muskox (Umikmak)

Bos moschatus Zimmermann, Geogr. Geschichte, 2:86, 1780, type from between Seal and Churchill rivers, Manitoba, Canada.

Ovibos moschatus, True, U. S. Nat. Mus., 7(App., Cir., 29): 592, November 29, 1884. (Also Richardson, 1829:275; Murdock *in* Ray, 1885:98; Turner, 1886:203; Nelson and True *in* Nelson, 1887:233; Lydekker, 1898: 142; Russell, 1898:232; W. Stone, 1900:35; Hornady and Brower, 1911:745; J. A. Allen, 1912:720; 1913:183; Anderson *in* Stefansson, 1913b:506; Lydekker, 1913:225; Seton, 1929:378; Hone, 1934:5; G. M. Allen, 1942: 329; Anderson 1947:183; Rausch, 1951:192.)

Ovibos moschatus niphoecus, Dufresne, Alaska's animals and fishes, A. S. Barnes and Co., New York, p. 46, 1946.

Description.—Robust, buffalolike ruminant, 4 to 5 ft. high at shoulder, with large head, hairy muzzle, short neck, short tail and short stocky legs; feet each with four hooves; skull massive and heavy; horns in both sexes unbranched, broad and thick at base where they nearly meet at midline of skull; horns curve downward along side of head then out and up; pelage black except for brownish black of upper parts; feet and nose white; occasional white hairs on face; underfur thick and wooly; 32 teeth.

Measurements (from Seton, 1929(3):596) of adult males: Total length, 2,028-2,434; tail, 98-102; hind foot, 432-483; height at shoulder, 1,217-1,521; weight up to 900 lbs.

The muskox is extinct on the Arctic Slope of Alaska. Information attached to a skull at the Arctic Research Laboratory (see No. 6 in records) states that there were no other bones showing where the skull was taken from a bank.

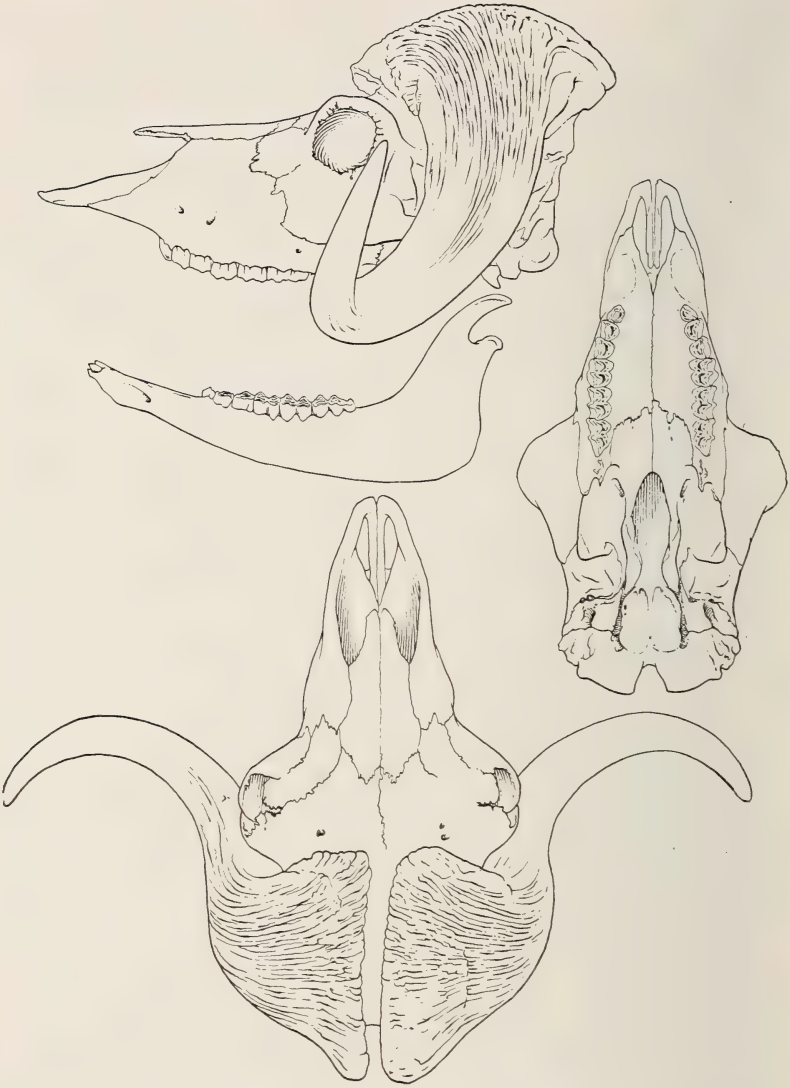


Fig. 119. Skull of *Ovibos moschatus*, near head of Wagner Inlet, Hudson Bay, No. 19490 AMNH, ♂ (approximately 7 years old). × approximately ⅙. Dorsal view and lateral view after *a* and *b* of fig. 16 Mem. Amer. Mus. Nat. Hist., N.S., 1(pt. 4):125, March 1913. Lateral view of lower jaw and ventral view of skull after photos from American Museum of Natural History.

Records of occurrence.—Specimens examined, none.

Records: (1) Point Barrow (G. M. Allen, 1942:330, "according to Frank Russell, 1898. . .oldest natives say that their fathers killed muskox which were then abundant"); on tundra, Point Barrow (W. Stone, 1900:35); Arctic Coast (Dufresne, 1946:46); (2) some distance up Koog [Kunk] River (Hornaday and Brower, 1911:755, information from Charles D. Brower that probably last group of muskox on the Arctic Slope was killed in 1858; Stefansson *in* J. A. Allen, 1913:188); (3) west side of Kupuk Island, Colville Delta about 5 miles below the mouth of the Stkillik River (largest eastern affluent of the Colville, near its mouth) (Anderson *in* J. A. Allen, 1913a:186); (4) near mouth of little creek about 2 miles west of the western mouth of Colville River (Anderson *in* J. A. Allen, 1913a:186); (5) mouth of the Colville (Murdock *in* Ray, 1885:98; Nelson and True *in* Nelson, 1887:233); (6) in bank on east side of lake at approximately 151°38′, 70°18′, near Fish Creek (skull picked up by Steve Roberts and John C. Bollenbocker on August 18, 1949—*fide* J. W. Bee, MS, 28 July 1951); (7) Colville River Valley [definite locality unspecified] (Anderson *in* J. A. Allen, 1913a:186); (8) [definite localities unspecified]: [Arctic Slope] "across the continent of America from Hudson Bay to the Asiatic seas" (Pennant, 1793:32); "barren grounds of North America" (Richardson, 1829:275); "Arctic America as far [west] as Eschscholtz Bay" (Lydekker, 1898:144); "Arctic America" (Lydekker, 1913: 266); (9) near Anderson Point, Camden Bay, 10 mi. E of Collinson Point (recovered by E. dek. Leffingwell according to Hone, 1934:8); (10) Rumiantzof [Romanzof] Mountains and near the Arctic Coast (Turner, 1886:203); (11) Tulugak Creek (Rausch, 1951:193).

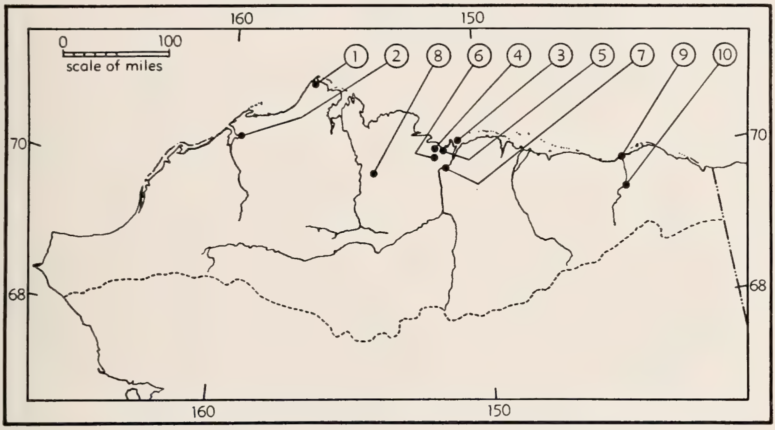


FIG. 120. Record stations of occurrence for *Ovibos moschatus moschatus.*

Ovis dalli dalli Nelson
Dall Sheep (Ipnaik)

Ovis montana dalli Nelson, Proc. U. S. Nat. Mus., 7:13, June 3, 1884, type from mountains south of Fort Yukon on west bank of Yukon River, Alaska. (Also True, 1884:592; Turner, 1886:203.)

Ovis montana, Murdock *in* Report of the International Polar Expedition to Point Barrow, Alaska, by P. H. Ray, House of Representatives, 48th Congress, 2nd Session, Ex. Doc. No. 44, p. 98, 1885.

Ovis dalli, J. A. Allen, Bull. Amer. Mus. Nat. Hist., 9:112, April 8, 1897. (Also Nelson, 1898:128; Elliot, 1901:47; Hornady, 1901:82; Stone and Cram, 1905:64; Elliott, 1905:55; Preble, 1908:157; Anderson *in* Stefansson, 1913b:508; Hewitt, 1921:84; Moran, 1928:14; Dufresne, 1946:41.)

Ovis dalli dalli, J. A. Allen, Bull. Amer, Mus. Nat. Hist., 31:27, March 4, 1912. (Also Seton, 1929:576; Bailey and Hendee, 1926:23; Anderson, 1934b:212; Dixon, 1938:212; Cowan, 1940:525; G. M. Allen, 1942:349; Anderson, 1947:185; Rausch, 1950c:466; 1951:193.) Regarded by Nasonov, 1923 (see Sushkin, Jour. Mamm., 6:150) as a subspecies of *O. nivicola*.

Ovis canadensis dalli, Nelson and True, *in* Arctic Series No. 3 of publications issued in connection with the Signal Service, U. S. Army, by Nelson, pp. 233, 282, 1887. (Also McConnell, 1892:131; Lydekker, 1898:219; 1901:15; 1913:118; Rausch, 1953:144.)

Description.—A sleek sturdy white sheep about 3 feet high at shoulder; horns massive (see fig. 121); chin beardless; a gland between hooves and one under each eye.

External measurements of four adult males from Nahanni River region south of the Brooks Range (from Cowan, 1940:526) averaged as follows: Total length, 1428; tail, 102; hind foot, 408; height at shoulders, 940; ear from notch, 74; forehoof, 69; hind foot, 66. Weight (from Brooks Range, Rausch, 1951:194) of old adult male, 190 lbs.; adult female, 115 lbs. Cranial measurements of 16 males from various localities within the range of *dalli* (from Cowan, 1940:526) are: Basilar length, 249; zygomatic width, 122; upper molar series, 76. Skull with massive horns coiled in a flat spiral, and with transverse ridges; horn curved backward, downward and outward and in old adults, upward; females with short thin horns; teeth usually 32; pelage hairy not wooly, predominantly white with some black hairs in tail.

Distribution, Relative Abundance and Habitat

The Dall sheep is widely distributed in the Brooks Range and is generally a common mammal wherever steep slopes are present. Charles Hummel, of the United States Geological Survey, told us that in the summer of 1951 Dall sheep were numerous in the high mountains at the headwaters of the Colville River near the crest of the Brooks Range and that they ranged north to the foothills. Ralph Steiner also found that sheep were common in the Brooks Range west of Chandler Lake but that they were more numerous in the Romanzof Mountains on an air line between Barter Island and Fairbanks. Harmon Helmericks, while flying between Lake Schrader and Chandler Lake, counted 146 sheep and, like Steiner, thought that the sheep were more numerous in the Romanzof Mountains southwest of Lake Schrader than elsewhere. On July 18, 1952, while flying down the Canning River from Porcupine Lake to the mouth of the canyon, which is in the general area of the observations made by Steiner and Helmericks, we observed sheep in groups of 1, 5, 10, 7, 2, and 6. These sheep occurred from the gravel benches along the river, which were

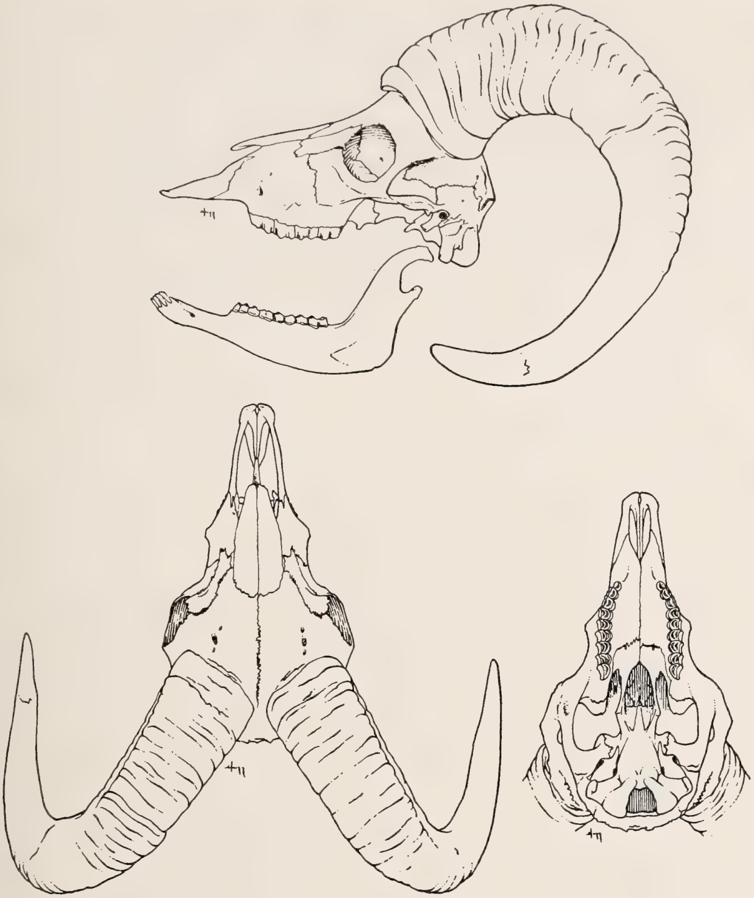


FIG. 121. Skull of *Ovis dalli dalli,* Knick River, Cooks Inlet, Alaska, August 1896, 1845 KU, ♂. × ⅙.

some distance from the sides of the canyon, up onto the ridges and peaks high above the floor of the canyon. At Chandler Lake, on the east facing slopes of the mountains at the south end of the lake, we observed sheep every day from August 14 to 25, 1951. Most of these sheep were in pairs but some were seen alone and others were in groups of as many as seven individuals. They were occupying the upper third of the mountains, usually on open vegetated slopes adjacent to high rocky cliffs. Some of these sheep remained on precipitous slopes beyond good feeding areas throughout the day. The sheep on the high windswept slopes were exposed to the most severe climate that there was in the Brooks Range. At Wahoo Lake in the first part of July, sheep were on the most precipitous slopes in the vicinity of the lake. On July 9, two ewes and two young remained in one area all afternoon.

The Dall sheep feed in 'sky meadows' near the altitudinal limit for plant growth. In winter, sheep browse the tops of willows exposed above the surface of the snow and feed on other vegetation that they dig out of the snow on the floors of canyons. Willows, that we saw in summer, on the winter range of the sheep have the stems defoliated from approximately two-thirds of a meter above the ground to approximately one and one-third meters. This type of growth of willows probably is produced by sheep browsing part of the shrubs above the snow in winter, and is especially common at the mouths of canyons.

It is not known what predators are most important in the ecology of sheep in summer. In winter, the greatest natural killer may be deep snows combined with severe climate. According to Eskimos, sheep congregate in large herds at the mouths of canyons in winter and from one such herd an Eskimo from Barter Island some years ago killed 140 sheep on one trip into the Romanzof Mountains. In autumn and winter at Chandler Lake low on the sides of the mountains the sheep use the same foraging area that caribou use in summer. At Lake Peters on July 31, 1952, caribou had grazed the slopes of Mount Mary and Mount Chamberlin in the summer range of the Dall sheep.

On the slopes high above Lake Peters, several overhanging ledges were used by sheep for protection from rains. The floors under these ledges were covered to a depth of several centimeters with the black fecal pellets. On the platform beyond the protective lip of such a ledge the pellets made fertile soils supporting luxuriant grasses. These ledges were at an elevation higher than that at which grasses normally grew. Many of these protective ledges were only a meter high—not high enough to afford protection to caribou, which therefore do not contribute to the fertility of the mentioned soils.

On August 17, 1951, at Chandler Lake seven sheep were resting in a compact group on a bench high on the side of the mountain, on the sunny lee side of a ridge. Sheep selected high slopes that supported good forage and that were varied enough in topography to allow sheep to gain shelter from winds that varied throughout the day. High slopes difficult of access by animals other than sheep usually were adjacent to the resting and foraging areas. Sheep did not seem to be annoyed by insects.

A flock usually consisted of from one to several females and two males. Males spend much time fighting, especially when females are moving on the slopes. Noise from the contact of the horns resounds throughout the canyon. In a side canyon west of the south end of Chandler Lake on August 19, 1951, one of us stalked a group of sheep from a distance of approximately 2000 meters. The females at once detected the intruder and retreated to high precipitous slopes. The two males were fighting and remained where first seen until the observer was within 200 meters of them. The younger of the two males was attempting to keep the older male from ascending to the upper slopes where the females were. The younger and smaller ram always kept above the older animal and utilized to advantage the momentum gained in downhill plunges. His many feints worried the older sheep. There seems to be a critical period late in the life of a ram after which he has little or no control of the females. As judged from the fighting between other males, it seemed that on August 19 the rutting season was well along in the Chandler Lake area.

At 11:25 a.m. we watched a male cross the floor of the canyon south of Lake Peters. When first observed this sheep was descending the slope of Mount Mary. He paused on top of the cliff at Weasel Point, then descended to the alluvium of the main canyon floor but was loath to leave the canyon side and did so only after cautiously testing our intention five times either by walking, running or charging at us. Finally he forded the shallow river in four jumps and after shaking off the water, ran as fast as he could across the floor of the valley to the slope of Mount Chamberlin. When approximately 100 meters above the floor of the canyon he began to graze leisurely toward Chamberlin Canyon. An eagle lit approximately 50 meters from the sheep as it first started to gain altitude on the side of the mountain. The imprints of a forefoot of this animal measured 70 mm in length and 55 mm in greatest width; the rear foot measured 78 mm in total length and 65 mm in greatest width. The concave edge of the individual toe on the front foot is on the inside whereas the concave edge of the toe on the rear foot is on the outside and the points of the hind toes are more widely separated than are those of the forefeet. The rear feet made the deepest imprints in the sand.

According to Harmon Helmericks, the sheep at Lake Schrader are smaller and have brownish horns, whereas those at Chandler Lake are larger and have black horns. Color of the horns may be associated with age.

A horn picked up at Chandler Lake, measured 95 mm in diameter at the base and 305 mm in height.

Records of occurrence.—Specimens examined, none.

Records: (1) Hulahula River, 144°27′, 69°27′ (12 seen by Charles W. Whittington on June 28, 1948—*fide* J. W. Bee, MS, 8 September 1952); (2) Hulahula River, 144°20′00″, 69°27′20″ (one seen by Charles W. Whittington on June 28, 1948); (3) Okpilak River [all along river in mountains] (repeatedly seen by Leffingwell, 1919:63); (4) Hulahula River, Endicott Mountains [where on Hulahula River unspecified] (Cowan, 1940:528); (5) near Lake Schrader (skulls, picked up by Rausch, 1953:144); (6) Mount Mary, 145°10′00″, 69°20′15″ (four seen by James W. Bee on August 15, 1952); (7) mouth Chamberlin Canyon, 145°09′00″, 69°20′45″ (one seen by James W. Bee on August 15, 1952); (8) headwaters of the Sadlerochit [definite locality unspecified] (Leffingwell, 1919:63); (9) Canning River, 146°02′, 69°14′ (six seen by James W. Bee on July 18, 1952); (10) Canning River, 145°48′, 69°13′ (two seen by James W. Bee on July 18, 1952); (11) Canning River, 146°00′, 69°10′ (seven seen by James W. Bee on July 18, 1952); (12) SW of Lake Schrader in Romanzof Mountains (largest population between Lake Schrader and Chandler Lake seen by Harmon Helmericks in summer of 1947 —*fide* J. W. Bee, MS, 16 August 1952); (13) Canning River [all along river in mountains] (Leffingwell, 1919:14); (14) Romanzof Mountains [where in Romanzof Mountains unspecified] (Cowan, 1940:528); in Brooks Range on air route between Barter Island and Fairbanks (reported as abundant by Ralph Steiner—*fide* J. W. Bee, MS, 4 September 1951); (15) headwaters of Hulahula River [definite locality not specified] (Leffingwell, 1919:63); (16) Wahoo Lake, 146°58′, 69°08′, 2350 ft. (two seen by Richard Olson on July 3, 1952); (17) Canning River, 146°07′, 69°01′ (ten seen by James W. Bee on July 18, 1952); (18) Cape Beaufort (Bailey and Hendee, 1926:23); (19) 5 to 6 mi. inland from Cape Beaufort (Nelson and True *in* Nelson, 1887: 284); (20) Canning River, 146°02′, 68°56′ (five seen by James W. Bee on

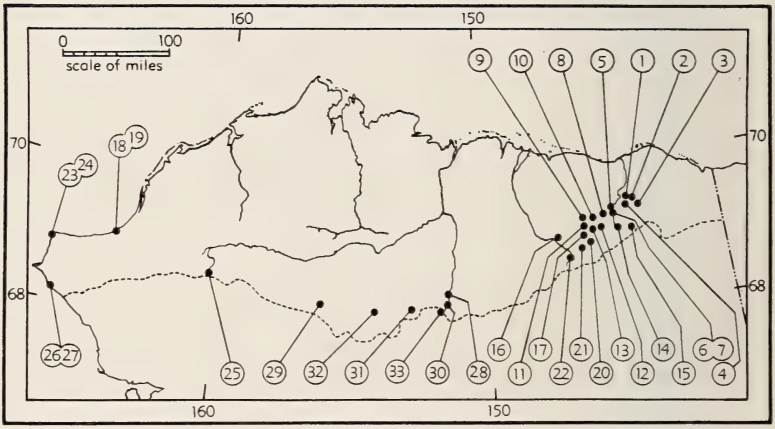


FIG. 122. Record stations of occurrence for *Ovis dalli dalli.*

July 18, 1952); (21) Canning River, 146°12′, 68°52′ (one seen by James W. Bee on July 18, 1952); (22) heads of nearly all the rivers [from the international boundary] to the Colville River [where at the heads of the rivers unspecified] (Anderson *in* Stefansson, 1913b:508); (23) Cape Lisburne (Nelson and True *in* Nelson, 1887:284; Bailey and Hendee, 1926:23); (24) Camp Lewis, 10 mi. S Cape Lisburne (Cowan, 1940:528); (25) near crest Brooks Range, head of Colville River (many seen by Charles Hummel in June and July of 1950—*fide* J. W. Bee, MS, 11 June 1952); (26) Cape Thompson (one killed by Jacob A. Stalker in 1937); (27) Cape Thompson, about 5 mi. from coast, 300 ft. (Nelson, 1884:13, and Lydekker, 1898:220); (28) along Anaktuvuk (Rausch, 1950c:466); (29) west of Chandler Lake (numerous and seen by Ralph Steiner in 1949—*fide* J. W. Bee, MS, 4 September 1951); (30) mountains around Tolugak [Tulugak] Lake (Rausch, 1950c:466); (31) Chandler Lake, 152°45′, 68°12′, 2900 ft. (18 seen by James W. Bee on August 14, 1951); (32) [Brooks Range with definite locality unspecified] mountains of Alaska (True, 1884:592); low range of mountains a few miles back from the coast between [Cape Thompson] and Point Barrow, Nelson, 1884:13; Romanzoff Mountains ? (Murdock *in* Ray, 1885:98); as far N as lat. 68° (Turner, 1886:203); Romanzof Mountains and west to Bearing Straits (Nelson and True *in* Nelson, 1887:284); near Cape Lisburne (Nelson and True *in* Nelson, 1887:284); along the Rocky Mountains from the Arctic Ocean southward (McConnell, 1892:132); from low hills beyond tree limit near the Arctic Coast south (Nelson, 1898:128); as far north as 70° in Alaska (Lydekker, 1898:220); low hills beyond the tree limit near the Arctic Coast (Lydekker, 1898:221); Alaska mountains (A. J. Stone, 1900:43; Elliot, 1901:47); [from international boundary] westward to the Romanzof Mountains and beyond to the Arctic Coast at Cape Beaufort (Hornady, 1901:87); mountain ranges of Alaska from those bordering the Arctic Ocean south (G. M. Allen, 1942:350); Alaskan mountains north of 60° to the Arctic Coast (Stone and Cram, 1905:64); Alaskan mountains (Elliot, 1905:55); Alaska (Trouessart, 1904-05:714); greater part of Alaska (J. A. Allen, 1912a:28; Lydekker, 1913:118); heads of nearly all the rivers on the Arctic side of the divide [Endicott Mountains] at least as far west as the Colville (Anderson *in* Stefansson, 1913b:508); Endicott Range (Seton, 1929:581); Alaska [Brooks Range] (Moran, 1928:14); Brooks Range on map (Anderson, 1934b:4069); mountains of northern Alaska (Dixon, 1938:212, 213); Brooks Range (Dufresne, 1946:39); mountains of Alaska [Brooks Range] (Anderson, 1947:185); (33) Anaktuvuk Pass (Rausch, 1951:194); Arctic Slope on map (Burt and Grossenheider, 1952:162).

SOME MAMMALS, POSSIBLY OCCURRING ON THE ARCTIC SLOPE, FOR WHICH SATISFACTORY RECORD IS LACKING

Lepus americanus dalli Merriam, Snowshoe Rabbit (Ukliatchiak).—We would not be surprised to find this rabbit on the Arctic Slope where continuous, or nearly continuous, avenues of riparian vegetation providing high overhead protection connect with the forests on the south side of the Brooks Range. Rausch (1951:177) reports snowshoe rabbits from Kalutak Creek which is approximately eight miles south of the Arctic Slope. Anderson (*in* Stefansson, 1913b:514) says of *Lepus a. macfarlani* that. . .only a very few scattering tracks were seen on either side of the Endicott Mountains. Some of the occurrences of *Lepus* noted on page 34 in the account of *Lepus othus* conceivably relate instead to *Lepus americanus.*

Tamiasciurus hudsonicus preblei A. H. Howell, Red Squirrel (Sakalatayik).—The red squirrel may occur occasionally on the Arctic Slope in the willows and alders at the heads of streams draining the Brooks Range.

Rausch (1953:126) took a specimen near Anaktuvuk Pass (probably head of John River on the south side of the crest of the Brooks Range) and in the Savioyok Valley east of Anaktuvuk (approximately 10 miles south of the crest of the Brooks Range). Marvin Mangus saw one at the head of Hunt Fork, which is less than 10 miles from the crest of the Brooks Range.

Castor canadensis canadensis Kuhl, Beaver (Kigiak).—Near the mouth of the Kuparuk River, 149°30′, 70°00′, tracks were noted by George Wood in 1949 and by Harmon Helmericks in the summer of 1951; they saw tracks also at the junction of the East Fork and West Fork of the Sagavanirktok River, 148°30′, 69°28′, in 1949. No specimens were obtained. Marvin Mangus told us that he had never seen a beaver on the Arctic Slope. Forty-five miles south of the crest of the Brooks Range he saw one at the junction of Crevice Creek and the John River on August 15, 1951, and another on August 16, 1952, on the Scheenjek River at the mouth of Old Woman Creek, which is approximately 40 miles south of the crest of the Brooks Range. The Eskimos and Indians at Bettles told us in 1951 that there are beaver on the John River as far north as Hunt Fork, which is approximately 17 miles south of the crest of the Brooks Range.

Ondatra zibethicus spatulatus (Osgood), Muskrat (Kivgaluk).—In 1952, when 46 years old, Oliver James Anashuk, from Barrow Village, told us that "many years ago" he saw about 50 holes in the ice, each hole being approximately 90 millimeters in diameter, that were being kept open on lakes south of Point Barrow, near the Brooks Range. As nearly as he could estimate, this place was along the Awuna River at or near 157°30′, 69°18′. According to his memory there were no plant clippings at the entrances of these holes. They were the only holes of this type that he ever saw on the Arctic Slope. We speculated that muskrats may have been responsible. The Eskimos and Indians at Bettles say that muskrats occur in the John River as far upstream as Hunt Fork, a place approximately 17 miles south of the crest of the Brooks Range.

Martes americana actuosa (Osgood), Marten (Kaviatchiak).—Rausch (1951:174) reports that in the winter of 1949-50, tracks of the marten were seen in the Savioyok Valley which is less than 10 miles south of the crest of the Brooks Range and that an Eskimo had killed one along the Hunt Fork not more than 17 miles south of the crest of the Brooks Range. In the temperate region the marten frequently inhabits rock fields above timberline and it is not unlikely, therefore, that this animal occasionally will be found on the Arctic Slope.

Enhydra lutris lutris (Linnaeus), Sea Otter.—Clifford Fiscus reported to us that Albert Driggs saw a sea otter in 1951 at Cape Halkett, 152°16′, 70°49′, and another in 1952 at Atigaru Point, 151°50′, 70°35′. No specimen was obtained. These are the first reports of sea otter north of the Bering Sea. See fig. 105 on page 220.

In canyons on the north-facing slope of the Brooks Range it would not be surprising to find *Synaptomys borealis, Microtus pennsylvanicus, Microtus xanthognathus* and *Zapus hudsonius.* Along the coast one or two additional species of seals and several additional cetaceans may occasionally occur.

KEY TO THE SPECIES OF MAMMALS OF THE ARCTIC SLOPE OF NORTHERN ALASKA

1. Head and body less than 80 mm; hind foot less than 16 mm. Canine teeth always present and same size as adjacent teeth; zygomatic arch lacking.

  2. Length of tail less than 37 mm (average 32 mm); sides paler than back. Third unicuspid tooth always as large as (often larger than) fourth unicuspid.

    3. Weight of males and non-pregnant females less than 5.5 gms. Condylobasal length of skull less than 16.7 mm; maxillary breadth less than 4.5 mm; unicuspid teeth with indentation on anteromedial surface; postmandibular foramen absent. .... *Sorex cinereus* (cinereous shrew), p. 15.

    3′. Weight of males and non-pregnant females more than 5.5 gms. Condylobasal length of skull more than 16.7 mm; auxiliary breadth more than 4.5 mm; unicuspid teeth without indentation on anteromedial surface; postmandibular foramen present. .... *Sorex arcticus* (Arctic shrew), p. 22.

  2′. Length of tail of adult more than 37 mm (average 45 mm); sides colored like back instead of ordinarily paler than back. Third unicuspid tooth smaller than fourth. .... *Sorex obscurus* (dusky shrew), p. 28.

1′. Head and body of adults more than 80 mm; hind foot more than 16 mm. Canine teeth (when present) conspicuously larger than adjacent teeth; zygomatic arch present (except in some whales).

    4. Two incisors below and 2 above, or 2 below and 4 above (in rabbits two incisors are small and lie flat against the back sides of the front incisors).

      5. Tail powderpufflike; ear longer than tail vertebrae. Total of 4 incisors above and 2 below; total of 10 or 12 molariform teeth above and 10 below; enamel extending to posterior face of incisors; side of rostrum extensively fenestrated; jugal extending backward to form strong projection at posterior end of zygomatic arch.

        6. Ear from notch usually more than 73 mm when dry than 67 mm; first upper incisor inscribing an arc of base; tail always white. Basilar length of skull more than 67 mm; first upper incisor inscribing an arch of a circle the radius of which is more than 9.6 mm. .... *Lepus othus* (tundra hare), p. 31.

        6′. Ear from notch usually less than 73 mm when dry or 77 mm when fresh; pelage in winter white only on tips of hairs; tail not always white. Basilar length of skull less than 67 mm; first upper incisors inscribing an arc of a circle the radius of which is less than 9.6 mm. .... (not yet known from Arctic Slope) *Lepus americanus* (snowshoe hare), p. 261.

5′. Tail not powderpufflike; ear shorter than tail vertebrae. Total of 2 incisors above and 2 below; total of molariform teeth never more than 10 above and 8 below; enamel restricted to anterior face of incisors; side of rostrum not extensively fenestrated; jugal not extending backward to form a projection at posterior end of zygomatic arch.

  7. Tail bushy or (in beaver) dorsoventrally flattened and nearly hairless. Infraorbital canal round or ovoid but never slitlike; width of facial opening of this canal on or near maxillary plate of zygoma less than width of any molar tooth.

    8. Toes of hind feet never webbed; fleshy part of tail round with hair on middle of tail longer than diameter of fleshy part of tail. Cheek-teeth rooted, brachyodont, tuberculate and capped with enamel; postorbital processes present. Diurnal, terrestrial.

      9. Line of black on sides separates light underparts from dark upper parts; cheek-pouches absent. Width of P4 less than half width of M2; active all winter; nests seldom far from conifer or other large tree.............(not yet known from Arctic Slope) *Tamiasciurus hudsonicus* (red squirrel), p. 261.

      9′. No line of black on sides separating light underparts from dark upper parts; cheek-pouches present. Width of P4 more than half width of M2; hibernates; nests underground and usually not associated with high trees.

        10. Total length more than 460 mm.; feet black; hind feet more than 66 mm; pelage not flecked with white. Dorsal profile of skull nearly straight; interorbital region slightly depressed; postorbital process approximately at right angles to main axis of skull; basilar length of skull more than 66 mm; anterior lower premolar with a protoconule. Call a shrill whistle...*Marmota caligata* (hoary marmot), p. 35.

        10′. Total length less than 460 mm; feet not black; hind feet less than 66 mm; pelage flecked with white. Dorsal profile of skull convex; interorbital region not depressed; postorbital process directed obliquely backward; basilar length of skull less than 66 mm; anterior lower premolar without a protoconule. Call ordinarily a double note given in quick succession..............*Spermophilus undulatus* (Arctic ground squirrel), p. 43.

    8′. Toes of hind feet webbed; fleshy part of tail flattened dorsoventrally, nearly devoid of hair. Cheek-teeth rootless (except in old age), hypsodont, the crowns formed of enamel ridges enclosing spaces of dentine; postorbital process absent. Mainly nocturnal, aquatic..................................(specimen not yet known from Arctic Slope) *Castor canadensis* (beaver), p. 262.

  7′. Tail not bushy, not dorsoventrally flattened and not nearly hairless. Infraorbital canal a vertical slit, or, if circular, restricted to maxillary plate of zygoma and wider than crown of any molar tooth.

11. Body and tail without quills. Cheek-teeth never more than three in each jaw; infraorbital canal a vertical slit and narrower than foramen magnum.

  12. Tail less than 20 mm. Lower incisors lingual to molars and terminating in horizontal ramus opposite, or in front of, alveolus of m3.

    13. Claws of digits 2 and 3 of forefeet having extra basal growths in winter; pelage white in winter; rump not red (in animals older than post-juveniles); dark median stripe on back (in summer) generally present. Thirty-nine to 41 closed triangles and/or loops in the six lower molars; inner and outer salient angles of upper molars approximately equal in size (same is true in lower molars); supraorbital ridges prominent but not fusing in interorbital region; anterior surface of squamosal bearing peglike process.................................. *Dicrostonyx groenlandicus* (collared lemming), p. 57.

    13′. Claws of digits 2 and 3 of forefeet not developing extra basal growths in winter; pelage not white in winter; rump red (in animals older than post-juveniles); dark median stripes on back rarely present. Fewer than 39 closed triangles and/or loops in the six lower molars; inner salient angles of upper molars and outer salient angles of lower molars shorter than angles on opposite side of tooth; supraorbital ridges fusing in adults and forming median interorbital crest; anterior surface of squamosal lacking peglike process..........*Lemmus trimucronatus* (brown lemming), p. 74.

  12′. Tail in adults more than 20 mm. Lower incisors passing from lingual to lateral side of molars between roots of m2 and m3 and ascending behind molars to termination within or near condylar process.

    14. Entire back distinctly reddish. Molars rooted in adults; re-entrant angles lacking cement; inner and outer angles of molars rounded; postpalatal bridge present but may be discontinuous from one side to the other between the posterior molars; tympanic bullae lacking internal trabeculae........*Clethrionomys rutilus* (red-backed vole), p. 113.

    14′. Entire back never distinctly reddish. Molars rootless and evergrowing; cement present in re-entrant angles; outer angles of molars not rounded; posterior border of palate variously supported by a sloping median spine (elevating the palate above the level of the palatal pits) but never a straight-edged shelf; tympanic bullae possessing internal trabeculae.

15. Tail not compressed (instead round) and not scaly; toes on hind feet without stiff bristles; total length less than 200 mm. Molars rootless; skull less than 40 mm in condylobasal length; length of incisive foramina less than width of rostrum; posterior border of palate bridged; orbital margin of fused frontal and squamosal inclined posterolaterally and not shelflike.

16. Tail in adults rarely less than 37 (average 43) mm; color blackish. Zygomatic breadth usually more than 53.5 (average 55) per cent of condylobasal length.—————— *Microtus oeconomus* (tundra vole), p. 124.

16′. Tail in adults rarely more than 37 (average 31) mm; color buffy and "greenish". Zygomatic breadth usually less than 53.5 (average 51) per cent of condylobasal length.—————— *Microtus miurus* (singing vole), p. 136.

15′. Tail compressed (higher than wide) and scaly; toes on hind feet with stiff bristles; total length more than 200 mm. Molars rooted; skull more than 40 mm in condylobasal length; length of incisive foramina more than width of rostrum; posterior border of palate without palatal bridge; orbital margin of fused frontal and squamosal nearly at a right-angle with long axis of skull and projecting into orbit as thin-edged shelf.—————— (not yet certainly known from Arctic Slope) *Ondatra zibethicus* (muskrat), p. 262.

11′. Body and tail with quills. Cheek-teeth always more than three (usually four or five) in each jaw; infraorbital canal circular and larger than foramen magnum.—————— *Erethizon dorsatum* (porcupine), p. 156.

4′. Incisors (if any are present) not so arranged that there are 2 below and 2 above or 2 below and 4 above .

17. External hind limbs absent; tail a horizontal pair of flukes; forelimbs not differentiated into arm, forearm and digits; body hairless. Spiracle on top of head for breathing.

18. Cleft of mouth not curved. Teeth always present in the lower jaw and often in upper; no baleen; rami of lower jaw united by denticulations on symphyseal surfaces; spiracle single.

19. Dorsal fin absent. Teeth usually fewer than 10.

20. Color everywhere white; back with a hump. Males and females without spirally twisted tusk; teeth present.—————— *Delphinapterus leucas* (white whale), p. 158.

20′. Color above dark gray, below white, sides and back mottled with gray; back without a hump. Males with long spirally twisted tusk (canine) projected anteriorly; females usually not showing tusks externally; teeth (other than tusks) absent...*Monodon monoceros* (narwhal), p. 159.

19′. Dorsal fin present. Teeth usually more than 10.

21. Dorsal fin more than 250 mm in height; total length of males more than 8 (20 to 30) feet; black of sides contrasted with white of belly, white extending up on sides posteriorly; no dark line from corner of mouth to pectoral flipper. Teeth 10 to 13. Lives mainly offshore.................*Grampus rectipinna* (Pacific killer whale), p. 162.

21′. Dorsal fin less than 250 mm in height; total length of adults less than 8 (4 to 6) feet; black of back not contrasted with white of belly; dark line from corner of mouth to flipper. Teeth 16 to 26. Common near shore and in lagoons and at mouths of rivers. .... *Phocoena vomerina* (Pacific harbor porpoise), p. 162.

18′. Cleft of mouth curved. Teeth absent after birth; upper jaws furnished with plates of baleen; rami of lower jaw united by only fibrous tissues and not by bony denticulations; spiracle double.

22. Head less than ⅓ length of animal; 2 to 4 longitudinal folds on throat; pectoral fin enclosing 4 fingers; animal mottled gray (sometimes blackish). Baleen coarsely fringed, 14 to 18 inches long; cervical vertebrae free. Spouts quick and low; lives close to shore.................*Eschrichtius gibbosus* (gray whale), p. 164.

22′. Head more than ⅓ length of animal; no longitudinal folds on throat; pectoral fin enclosing 5 fingers; animal uniformily black or grayish brown. Baleen finely fringed, about 30 inches long; cervical vertebrae united. Spouts long and high; lives mainly offshore.................*Balaena mysticetus* (bowhead), p. 165.

17′. External hind limbs present; tail of modified limbs; forelimbs differentiated into arm, forearm and digits; body haired. No spiracle on top of head for breathing.

23. Without hooves. Postorbital bar incomplete; teeth not selenodont; no conspicuous diastema between canine tooth and jaw-teeth.

24. Limbs adapted for walking; digits free (except in *Lutra* and *Enhydra*) and clawed; first digit of hind foot not longer than other digits; external ears well developed. Lacrymal bone perforate; milk teeth present for some time after birth; molars and premolars unlike; carnassial tooth present. Terrestrial (except *Lutra* and *Enhydra*).
    25. Claws not retractile; bearlike or doglike. Four molars above and 6 molars below; 42 teeth.
        26. Total length less than 1225 mm; hind foot with four toes; tail more than 15 per cent of total length; feet digitigrade; doglike. Adult skull less than 305 mm (1 foot) in length; carnassials highly specialized and dentition of shearing type; M2 (may be lost in an occasional specimen) less than 1½ times as long as wide; all four premolars generally present.
            27. Pupil round; weight of adult more than 25 lbs.; length more than 1300 mm. Condylobasal length of skull of adult more than 160 mm; postorbital process thick and convex dorsally; width of zygoma at anterior edge of orbit more than 5 mm; temporal ridges united into high sagittal crest. Tail held low (*Canis latrans*) or high (*Canis lupus*) when running.
                28. Ears pointed and extending to eye when laid forward; rusty color present in normal pelage; weight of adult less than 50 lbs. Incisors without well developed inner and outer secondary lobes (noticeable especially in outer cusps of upper and lower third incisors); width of palate less than 31 per cent of alveolar length of tooth-row (P1 to M2); depth of jaw below anterior alveolus of M2 less than 15 per cent of length from the anterior end of dentary bone to posterior edge of condyle; width of rostrum measured across bases of upper canines less than 1¾ of anteroposterior extent of auditory bullae; dorsal profile of forehead not rising abruptly above rostrum.................*Canis latrans* (coyote), p. 168.
                28′. Ears rounded and not extending to eye when laid forward; red or rusty color not present or conspicuous in normal pelage; weight of adult more than 50 lbs. Upper and lower incisors with well developed inner and outer secondary lobes especially noticeable on outer edges of upper and lower incisors; width of palate more than 31 per cent of alveolar length of tooth-row (P1 to M2); depth of jaw below anterior alveolus of M2 more than 15 per cent of length from the anterior end of dentary bone to posterior edge of condyle; width of rostrum measured across bases of upper canines more than 1¾ of anteroposterior extent of auditory bullae; dorsal profile of forehead rising abruptly above rostrum........................*Canis lupus* (gray wolf), p. 170.

27′. Pupil elliptical; weight of adults less than 25 lbs; length less than 1300 mm. Condylobasal length of skull of adult less than 160 mm; postorbital process thin and concave dorsally; width of zygoma at anterior edge of orbit less than 5 mm; temporal ridges not united into sagittal crest. Tail held horizontally when running.

29. Normal pelage without bright red on back; white in winter; color of tip of tail not contrasting with color of rest of tail; ears rounded and partly concealed by hair of head; feet heavily furred in winter. Upper and lower incisors with well developed inner and outer secondary cusps (outer cusps are especially well developed); orbital angle more than 44 degrees; palatal width more than 31 per cent of alveolar length of tooth-row (P1 to M2); depth of jaw below anterior alveolus of M2 more than 15 per cent of length of jaw taken from anterior end of dentary bone to posterior edge of condyle; transverse diameter of upper canine at alveolus averages 40 per cent of length of exposed part of canine; dorsal profile of forehead rising abruptly above rostrum. Occasionally frequents ice-flows.........*Alopex lagopus* (Arctic fox), p. 180.

29′. Normal pelage with bright red on back but variable in different degrees toward black; pelage not white in winter; tip of tail always white; ears pointed and exposed; feet not heavily furred. Upper and lower incisors without well developed inner and outer secondary cusps (smallness of cusps especially noticeable on outer edge of upper and lower incisors); orbital angle less than 44 degrees; palatal width less than 31 per cent of alveolar length of tooth-row (P1 to M2); depth of jaw below anterior alveolus of M2 less than 15 per cent of length of jaw taken from anterior end of dentary bone to posterior edge of condyle; transverse diameter of upper canine at alveolus averages 33 per cent of length of exposed part of canine; dorsal profile of forehead not rising abruptly above rostrum. Does not frequent ice-flows...*Vulpes fulva* (red fox), p. 184.

26′. Total length more than 1225; hind foot with five toes; tail rudimentary and less than 14 per cent of total length; feet plantigrade; bear-like. Adult skull usually exceeding 305 mm (1 foot) in length; molariform teeth tuberculate; no highly specialized carnassials; M2 (always present) at least 1½ times as long as wide; tendency for premolars to become lost with advancing age.

30. Pelage not white. Combined length M1 and M2 approximately equal to breadth of palate; frontal region of skull arched; occipital condyles not protruding behind lambdoidal crest; P4 not trenchant; cusps on crushing surfaces of M1 and M2 indistinct. Terrestrial.

31. Claws on forefeet approximately twice as long as on hind feet; hump and mane on shoulders; tracks usually show claw marks; skull flattened; last upper molar more than 32 mm (1¼ inches) long and about 2½ times as long as first upper molar.............*Ursus horribilus* (grizzly bear), p. 188.

31′. Claws on forefeet not much longer than on hind feet; hump and mane on shoulders absent; tracks usually do not show claw marks; skull arched; last upper molar less than 32 mm (1¼ inches) long and about 2 times as long as first upper molar.............*Ursus americanus* (black bear), p. 198.

30′. Pelage white. Combined length of M1 and M2 less than breadth of palate; frontal region of skull flat; occipital condyles protruding behind lambdoidal crest; P4 more nearly trenchant; cusps on crushing surfaces of M1 and M2 distinct. Marine and on ice-flows (occasionally comes inland)............. ....*Thalarctos maritimus* (polar bear), p. 200.

25′. Claws more or less retractile (except in *Lutra* and *Enhydra*); not bearlike or doglike (except *Gulo* which is bearlike). Two molars above and 2 or 4 molars below; 28 to 38 teeth.

32. Hind foot with 5 digits; claws not completely retractile; pupil not elliptical; ears without tuft of hair; ruff of hair on sides of face. Rostrum not shortened, or if so, then whole top of head not uniformally convex; 6 molars (2 above and 4 below); total number of teeth 32 or more (old individuals may loose premolars or even molars).

33. Claws partly retractile; digits not fully webbed; head not noticeably broad and flat. Premolars 6 above and 6 below; 34 teeth.

34. Tail not bushy or only slightly so. Greatest length of skull less than 65 mm; teeth 34.

35. Width of pale area on underparts more than ¼ of circumference of body; white chin patch not surrounded by dark fur; underparts white or yellowish. Length of upper tooth-rows less than 20 mm in males and 17.8 mm in females; hind foot less than 54 mm. Terrestrial.

36. Tail with a black pencil in all pelages; mastoid breadth more than 17; in females mastoid breadth ordinarily exceeded by breadth of braincase. Usually lives on stony slopes, or along river courses............. ....*Mustela erminea* (ermine), p. 203.

36′. Tail without a black pencil and with at most a few black hairs at extreme tip; mastoid breadth less than 17; in both sexes mastoid breadth ordinarily exceeds breadth of braincase. Usually lives in marshy areas........*Mustela rixosa* (least weasel), p. 207.

35′. No pale area on underparts, or if present then restricted to a few white spots; white chin-patch surrounded by dark fur; underparts brown. Length of upper tooth-rows more than 20 mm in males and 17.8 mm in females; hind foot more than 54 mm. Semi-aquatic, along streams and lakes. ....*Mustela vison* (mink), p. 210.

34′. Tail bushy. Greatest length of skull more than 65 mm; teeth 38.

37. Tail more than ⅖ of length of head and body; basilar length of skull less than 90 mm; in m1, talonid shorter than trigonid...(not yet recorded from Arctic Slope) *Martes americana* (marten), p. 262.

37′. Tail less than ⅖ of length of head and body; basilar length more than 90 mm; in m1 talonid no shorter than trigonid...*Gulo luscus* (wolverine), p. 212.

33′. Claws not retractile; digits fully webbed; head broad and flat. Premolars 8 above and 8 below; 38 teeth.

38. Head and neck brown; toes webbed. Incisors 6 above and 6 below; teeth 36; P4 and m1 modified for cutting. Fresh water. ....*Lutra canadensis* (river otter), p. 215.

38′. Head and neck grayish or yellowish-white; toes completely webbed and feet flipperlike. Incisors 6 above and 4 below; teeth 32; P4 and m1 modified for crushing. Marine..................(no specimen yet preserved from coast of area treated here) *Enhydra lutris* (sea otter), p. 262.

32′. Hind foot with 4 digits; claws completely retractile; pupil elliptical; ears with tuft of hair; no ruff of hair on sides of face. Rostrum much shortened (see fig. 102) and entire top of head including rostrum uniformily convex; 2 molars (2 above and 2 below); teeth 28...*Lynx canadensis* (lynx), p. 217.

24′. Limbs short and finlike and enclosed to or beyond the elbows and knees within a common integument and adapted for swimming; first and fifth digit of hind foot longer than three middle digits which are shorter and subequal; external ears poorly developed. Lacrymal bone imperforate; milk teeth rudimentary and usually lost soon after birth; molars and premolars all similar in structure; carnassial tooth absent. Marine.

39. Hind legs capable of being turned forward and servicable in terrestrial locomotion; front flippers nearly as large as hind flippers; on forefoot, digits without distinct claws but with a broad cartilaginous border extending beyond digits; on hind foot, only rudimentary nail on first and fifth digit. Alisphenoid canal present. Occasionally active on land.

40. External ears, underfur and hair present. Anterior part of skull not greatly swollen; canines less than 100 mm long; incisors of deciduous and permanent dentition 6 above and 4 below; postorbital process of frontal present; mastoid processes in males not continuous with auditory bullae.________________________*Callorhinus ursinus* (northern fur seal), p. 219.

40′. External ears, underfur and hair absent. Anterior part of skull greatly swollen; canines more than 100 mm long; incisors of deciduous dentition 6 above and 6 below, permanent dentition 2 above and 0 below; postorbital process of frontal not present; mastoid processes in males continuous with auditory bullae.________________________*Odobenus rosmarus* (walrus), p. 220.

39′. Hind legs not capable of being turned forward and not servicable in terrestrial locomotion; front flippers smaller than hind flippers; on forefoot, digits with distinct claws but without cartilaginous border extending beyond digits; on hind foot, well-developed nail on first and fifth digit. Alisphenoid canal absent. Seldom active on land.

41. Muzzle narrow (see fig. 107), forehead not convex; digits of manus decreasing slightly in length from first to fifth, or first and second subequal; pupil vertical slit; color of body not uniform; mammae 2. Teeth closely set; space between upper canine and third incisor less than greatest diameter of canine at base of exposed part of tooth.

42. Pelage lacking streaks on back and lacking small rings on back. Greatest length of skull more than 178 mm; interorbital width more than 7 mm.

43. Pelage with spots but without large band of white around neck, front flippers or body; nose and face not black in adults. Posterior margin of palate V-shaped (see fig. 107); crowns of molariform teeth mostly 3-lobed; mandibular teeth obliquely implanted and overlapping..........................*Phoca vitulina* (harbor seal), p. 222.

43′. Pelage with large band of white around neck, another band around each front flipper and another around body in front of hind flippers; nose and face black in adults. Posterior margin of palate broadly U-shaped (see fig. 107); crowns of molariform teeth mostly simple; mandibular teeth not obliquely implanted and not overlapping..............*Phoca fasciata* (ribbon seal), p. 225.

42′. Pelage having continuous streaks on back and having also small rings of light fur on back (some of these rings surround dark spots). Greatest length of skull less than 178 mm; interorbital width less than 7 mm...*Phoca hispida* (ringed seal), p. 226.

41′. Muzzle broad (see fig. 107), forehead convex; middle digit of manus longest; pupil diagonal slit; color uniform; mammae 4. Teeth widely spaced; space between upper canine and third incisor more than greatest diameter of canine at base of exposed part of tooth....................*Erignathus barbatus* (bearded seal), p. 227.

23′. Hooves. Postorbital bar complete; teeth selenodont; wide diastema between canine tooth (if present) and jaw-teeth.

44. Second and fifth digits present; length of legs more than vertical depth of body. Upper canines usually present; antlers (no horns) branched, shed annually; lacrymal bone separated from nasal by an extensive antorbital fossa; two lacrymal foramina, situated anterior to border of orbit.

45. Pendant bell of skin on lower part of neck; lips pendulous; height at shoulders greater than at rump; lateral hooves not functional; color dark brown; muzzle only partly hairy. No upper canines; second upper molar more than 21 mm wide; vomer not dividing posterior nares into two chambers; distance from anterior ends of nasals to anterior tip of premaxillaries approximately equal to distance from posterior end of nasal to lambdoidal crest; antlers in males only; antlers palmate, with small prongs projecting from the borders; lowest prong not extending over face; base of pedicle that supports antler situated behind orbital cavity..............*Alces alces* (moose), p. 228.

45′. No pendant bell of skin on lower part of neck; lips not pendulous; height at shoulders not greater than at rump; lateral hooves functional; color brown; muzzle completely hairy. Upper canines normally present; second upper molar less than 21 mm wide; vomer dividing posterior nares into two chambers; distance from anterior ends of nasals to tip of premaxillaries less than distance from posterior end of nasal to lambdoidal crest; antlers in males and females; antlers round or only slight palmate; lowest prong extending over face; base of pedicle that supports antler extending over posterior part of orbital cavity...*Rangifer arcticus* (barren-ground caribou), p. 232.

44′. Second and fifth digits vestigial or absent; length of legs no more than vertical depth of body. Upper canines absent; horns (no antlers) not branched, not shed; lacrymal bone in contact with nasal, no antorbital fossa; one lacrymal foramen, situated inside rim of orbit.

46. Hair wooly and hanging down nearly to feet; color dark brown. Horncore in young lateral and gently deflected upward above the horizontal; horncore in adult deflected downward and slightly forward.......................................(extirpated on Arctic Slope) *Ovibos moschatus* (muskox), p. 253.

46′. Hair not wooly and not hanging down nearly to feet; color white. Horncore in young deflected posteriorly at approximately 45 degrees from the horizontal; horncore in adult spirally curved posteriorly, downward, foreward and then upward.......................................*Ovis dalli* (Dall sheep), p. 255.

CHARACTERISTICS OF THE MAMMALIAN FAUNA

Something already has been said in the Introduction concerning the mammalian fauna as a whole. It is noteworthy also that there are no species of mammals occurring only on the Arctic Slope itself or in the immediately adjoining oceans. Of the land mammals only the white fox, Arctic hare, collared lemming and muskox (extirpated in 1858 in Alaska) are confined to the Arctic Lifezone. Of the marine mammals only six live exclusively in Arctic seas.

The land mammals of the Arctic Slope, as would be expected, are adapted, probably by means of natural selection, to live in a cold climate. All have a thick coat of fur in winter to conserve bodyheat. The marmot and ground squirrel hibernate in winter and the grizzly bear becomes inactive. Many others in winter seek protection under the snow or in spaces between boulders. The species that remain on top of the snow in winter have remarkably thick coats of hair. The hairs are long, silky, larger at the distal than at the proximal ends, and are strong enough to withstand buffeting by wind. Also there is a dense growth of underfur. Furred footsoles protect against the cold and give traction on ice as seemingly do the seasonally enlarged claws of the collared lemming (see fig. 17). Reduction in size of ears and tail and increase in size of body is the rule on the Arctic Slope. The mammal begins winter with a thick layer of fat that insulates the animal and is a source of energy and heat in the long dark winter.

In the brief summer the winter coat is replaced by new hair short and sparse enough to permit the animals to benefit from the sunlight. In summer these mammals seem to be active for more of each 24-hour period than are mammals in temperate regions.

GEOGRAPHY AND CLIMATE

The Arctic Slope in northern Alaska is a vast area of 82,000 square miles bordered by the Arctic Ocean on the north, some 320 miles north of the Arctic Circle, and by the crest of the Brooks Range to the south. The west end of our area is where the Brooks Range meets the shore line near Cape Thompson and the eastern end of our area is the International boundary (Alaska-Canada) where the Brooks Range extends to within a few miles of the Arctic Ocean at Demarcation Point. Near the central meridian of the area, at Point Barrow, for example, the Brooks Range is more than 125 miles to the south. Three physiographic provinces are recognized; the Brooks Range, Plateau and Coastal Plain.

Brooks Range Province

The Brooks Range is one of the greatest mountain masses in North America. It is highest in the east where some peaks are more than 9,000 feet and is lowest in the west where peaks as high as 5,000 feet are the exceptions. The range is an elevated plateau of Paleozoic, Tertiary and Quaternary formations which have been dissected by running water and glaciers to produce many sharply defined canyons and rugged peaks. The north edge of this range is a bold escarpment and the internal structure of the range proper consists of folds, sometimes overturned, thrusts and high angle faults, which have been produced by compressional forces. It is remarkable that the strata retain their continuity although they have been much folded. The Lisburne Limestone, of Mississippian age is a resistant formation, which forms most of the higher and more rugged peaks. Wide, north to south valleys with low passes have been carved chiefly by Pleistocene glaciers. Other intermontane valleys, running east and west, result from downwarping, faulting and differential erosion. These valleys are unique in that Permian (Sadlerochit) and Triassic shales are exposed at the surface. In spring, waters from melting snow erode deep ravines. Bare rock surfaces are common and comprise considerable areas. The braided rivers, especially in the lower part of the Brooks Range and to the east, are gradually filling the canyons with sand and boulders. These rivers fluctuate in the daily cycle and also seasonally, frequently becoming dry in summer. In some local areas ice remains in river channels the year round. Moraines have produced an irregular surface, with numerous basins supporting lakes. They are deep and some are filling rapidly with alluvium as evidenced by the successional zones of vegetation on the sides of the lake receiving the deposition. These lakes, however, are relatively free of vegetation and are youthful. Elevated shore lines in some of the valleys and canyons are from lakes which were larger than those of today. The present glaciers (see fig. 123), for example Chamberlin Glacier, have receded in cycles and at present are just beginning a new period of recession that could be interpreted either as the beginning of a period of increasing warmth, or increasing cold on the Arctic Slope; by the latter interpretation it would be supposed that there was less moisture in the air because of the increasing cold. In July and August, both the days and nights in the Brooks Range are warmer than at Point Barrow for the same months; in the Brooks Range, however, the days, and especially the nights, are cooler than in the Plateau Province. The highest temperature that we recorded anywhere on the Arctic Slope was 85° F on July 17, 1952, at Porcupine Lake (see Table 5). In the Brooks Range, in spring, some lakes open earlier than those on the Coastal Plain and the ice disappears from the lakes in a remarkably short time; for instance, on July 20, 1952, 60 per cent of Lake Schrader was sealed with ice solid enough to walk on but three days later, only one per cent of the lake remained covered. On July 23 the ice, which was moving out of Lake Peters, melted as soon as it entered the warmer Lake Schrader. On July 2, 1950, Chandler Lake was ice-covered but on July 4 this ice was gone. The latter part of August, which is

Table 5. Air Temperatures at Several Localities in the Brooks Range in the Summer of 1952. Taken Daily at 11:59 p.m. with a Taylor Maximum-Minimum Thermometer Placed 20 cms Above the Ground in the Shade.

Wahoo Lake. 69°08′, 146°58′, 2350 ft.			
July 5.	36 min.	70 max.	40 at 11:59 p.m.
July 6.	40 min.	75 max.	41 at 11:59 p.m.
July 7.	42 min.	74 max.	40 at 11:59 p.m.
July 9.	40 min.	63 max.	40 at 11:59 p.m.
July 10.	40 min.	66 max.	40 at 11:59 p.m.
July 11.	36 min.	66 max.	44 at 11:59 p.m.
Porcupine Lake, 146°29′50″, 68°51′57″, 3140 ft.			
July 13.	37 min.	65 max.	42 at 11:59 p.m.
July 14.	38 min.	70 max.	42 at 11:59 p.m.
July 15.	34 min.	50 max.	46 at 11:59 p.m.
July 16.	33 min.	46 max.	42 at 11:59 p.m.
July 17.	33 min.	85 max.	37 at 11:59 p.m.
Lake Schrader, 145°09′50″, 69°24′28″, 2900 ft.			
July 24.	32 min.	46 max.	42 at 11:59 p.m.
July 25.	35 min.	50 max.	40 at 11:59 p.m.
July 26.	38 min.	56 max.	43 at 11:59 p.m.
July 27.	39 min.	62 max.	43 at 11:59 p.m.
July 29.	38 min.	62 max.	38 at 11:59 p.m.
July 30.	33 min.	48 max.	43 at 11:59 p.m.
Mount Mary, S end Lake Peters, 145°10′02″, 69°22′08″, 352 ft.			
July 31.	34 min.	58 max.	38 at 11:59 p.m.
Aug. 1.	36 min.	56 max.	44 at 11:59 p.m.
Aug. 2.	32 min.	70 max.	52 at 11:59 p.m.
Aug. 4.	42 min.	52 max.	42 at 11:59 p.m.
Aug. 5.	33 min.	52 max.	33 at 11:59 p.m.
Aug. 7.	28 min.	58 max.	42 at 11:59 p.m.
Aug. 8.	38 min.	—— max.	50 at 11:59 p.m.
Aug. 9.	42 min.	70 max.	42 at 11:59 p.m.
Aug. 10.	40 min.	63 max.	50 at 11:59 p.m.
Aug. 11.	42 min.	52 max.	44 at 11:59 p.m.
Aug. 13.	42 min.	53 max.	42 at 11:59 p.m.
Aug. 14.	32 min.	53 max.	43 at 11:59 p.m.
Aug. 15.	33 min.	43 max.	33 at 11:50 p.m.
(first snow on ground)			

usually the time of transition between summer and winter, is characterized by persistent cold drizzle. On August 15, 1952, the first snow fell in the valley at Lake Peters although snow already had accumulated on higher slopes. This first snow did not remain on the ground for more than one day. At Chandler Lake in 1951 the change from summer to winter began on August 5. Up until August 11, the prevailing winds were from the south. August 12 was windless, which was unusual for this time of year. The next day rain began accompanied by strong cold winds from the north. After the rain, low fog masses moved up the valley from the Plateau Province to the north. The minimum temperature was approximately 33°F. The period after August 13 was one of adjustment by mammals, including man, to inundated habitats and cold weather. On August 16, the first snow was deposited on the ground at the north end of Chandler Lake and to as low as 500 feet above the lake on the side of the canyon at the south end of the lake.

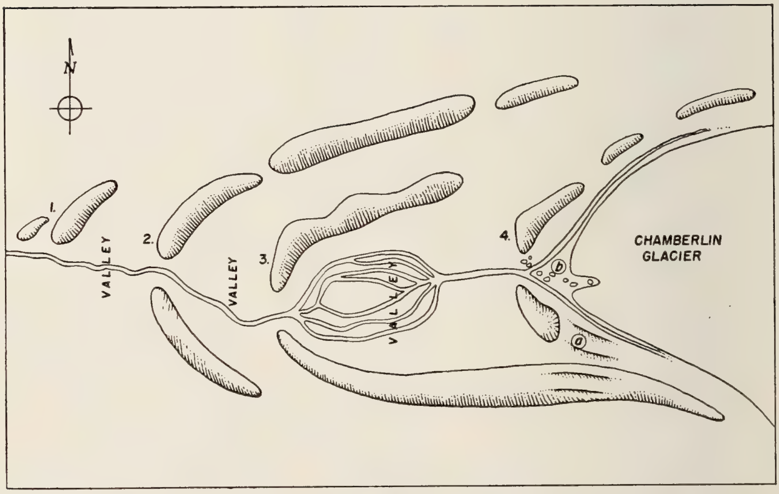


Fig. 123. Recessional moraines of Chamberlin Glacier, Brooks Range, Alaska, showing four of the major moraines which are associated with the receding glacier. At least six older moraines, not shown in the figure, are in the canyon between Chamberlin Glacier and the main glaciated canyon of Lake Peters. Valleys are between successive moraines, the uppermost valley being an outwash plain occupied by a broadly braided stream. Chamberlin Glacier has receded cylically and deposited minor lateral moraines (*a*) between the major lateral moraines. Nine piles of rock debris, (*b*) each formed at a different time as the glacier receded, are between the end of the glacier and the moraine last formed (4). The glacier now is retreating after a period when it had been stabilized for a considerable time.

Variable weather followed until about August 23 when the snow line again descended the mountains and the temperature dropped from a minimum of 31°F on August to 23°F on August 25. The temperature on the latter date rose to 40°F in the daytime as compared to the usual 45° to 55° of the previous week. August 21 marked the abrupt and dramatic color change of vegetation from green to yellows. Willows were responsible for most of the new yellow color; however, grasses and sedges, especially those in dry meadows and on slopes, were going through the same change. Grasses and sedges in standing water or in channels of water were least changed in color. The cotton-grass changed from green to greenish yellow but the basal part of each blade remained green. All of the leaves of the dwarf birch were then brilliant red. August 21 also was the time when the birds moved out of the area. In spring, on July 3, 1952, the Brooks Range, except for peaks near the crest of the range and gullies on the slopes and lee sides of the ridges, was free of snow. The range at that time was streaked in appearance. It was evident that wind controlled the deposition of snow.

Plateau Province

The Plateau Province extends north of the fault escarpment of the Brooks Range as a broad expanse of undulating uplands which have been elevated and differentially eroded. In many places the strata are exposed in long graceful lines. Rills of soil-creep radiate from the top of the steeper knolls like spokes of a wheel, and are parallel to each other on monoclines, while solifluction terraces develop as discontinuous horizontal benchlands. These terraces and soil-slides extensively modify the terrain. The major rivers of the Brooks Range have cut channels across the Plateau Province. Older but shallower drainage channels, unused at present, can also be traced across the plateau from south to north. Floors of river valleys, which have their sources in the Brooks Range, are extensively covered with sand and gravel deposited by waters of braided stream channels. The rivers in these channels flood in spring. When it rains they generally are muddy, whereas rivers having drainage only on the Plateau Province generally are clear and are sealed in with willows and alders and other shrubs. Old benchlands of former river valleys are on the sides of these present river valleys.

The Colville River carries water from the Brooks Range first to the east and thence to the north. This river, as well as many of the other larger rivers, has developed bluffs along the sides of the valleys. These bluffs are used by several kinds of raptores for nesting. Smaller streams on the upland are generally narrow and do not have bare erosional surfaces or deposits of gravels or sands. Most of the larger rivers are still frozen in early June, but are free of ice on or about June 17, and flood by July 1. Summers on the Plateau Province and in the Brooks Range Province are warmer (as high as 85°F), less foggy and windy, and have more precipitation whereas winters are colder (as low as —65°F) and have more snow than at Point Barrow on the coast. The minimum and maximum temperature in the summer of 1951 for four consecutive days at Kaolak River, 159°47′40″, 70°11′15″, are as follows: July 15, 64 min. 82 max.; July 16, 52 min. 72 max.; July 17, 44 min. 64 max.; July 18, 46 min. 58 max. The first snow comes later than in the extreme north but there is more of it and it remains longer in spring than to the north.

On June 14, 1952, in the southern part of the Plateau Province south of Umiat, snow was confined to the gullies on the north exposures and covered 40 per cent of the ground. Cornices were on north exposures only. Almost all lakes were frozen over and the ice on them was greenish blue. In the area of the Chandler River, south of Umiat, 80 per cent of the ground was covered with snow and the river was partly open and milky in color. North of the Colville River the cornices of snow were on south exposures. Ice on creeks was just beginning to break up and those that were not actually open were outlined by a yellow streak of snow. Snow gave the ground a spotty appearance. On July 3, 1952, between Umiat and the mouth of the Sagavanirktok River to the east, most of the large lakes were covered with ice but a few were free at the edges. Small lakes were free of ice, and there was snow only in deep gullies or on protected banks. The tundra was free of snow except for cornices on the east and north exposures of ridges and in deep gullies and braided river channels. From west to east there was progressively less snow and more green vegetation. Immediately below the mouth of the Ivashak Canyon 80 per cent of the braided river system was covered with permanent ice fields and the water was flowing in channels on top of the ice. In autumn, on September 12, 1952, the broad curved slopes and ridges were completely covered with snow which obscured the irregularities of the tundra. Dormant willows along the small creeks protruded above the snow. The river valleys and rock outcrops were free of

Plate 1

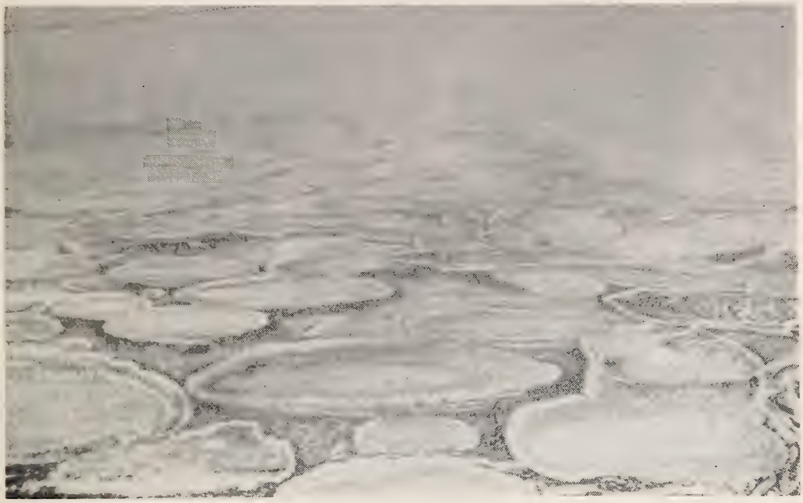


Fig. 1. View from airplane of Coastal Plain showing lakes (mostly oriented) and tundra, approximately 105 miles south of Point Barrow, June 14, 1952. Ice still is on lakes.

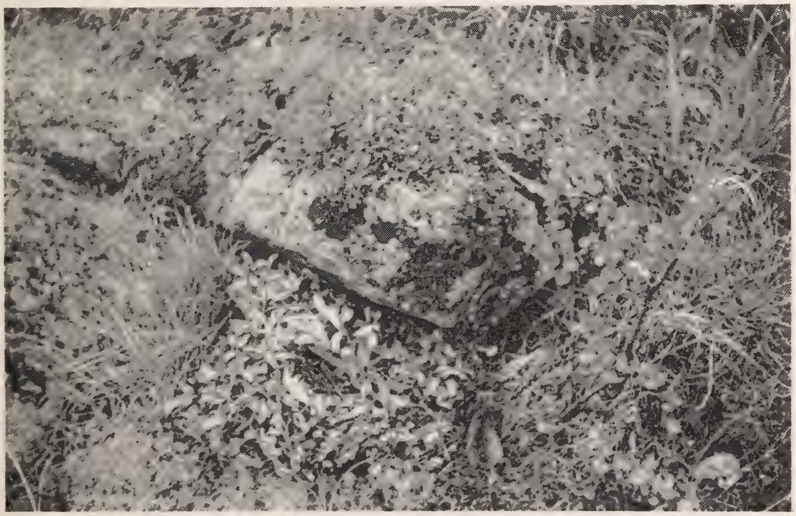


Fig. 2. Forage pile of willow leaves immediately below boulder. Leaves were cut and piled by the singing vole, *Microtus miurus*. The dead vole at the right of the pile was trapped in the position shown. Chandler Lake, 152°45′, 68°12′, 2900 ft., August 15, 1951.

Plate 2

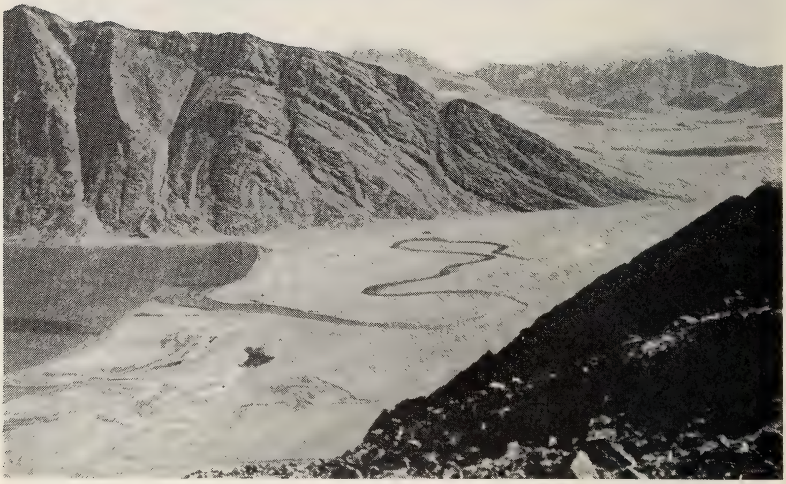


Fig. 1. Brooks Range with south end of Chandler Lake at left, August 25, 1951.

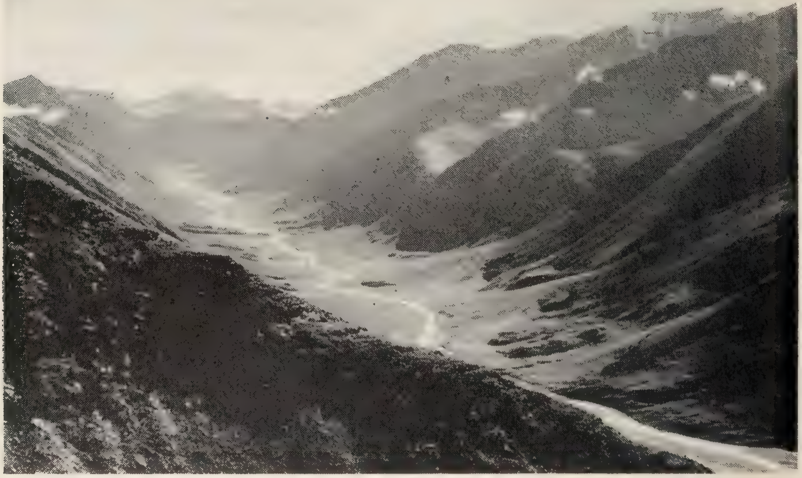


Fig. 2. Looking south (from mountain on east side of Lake Peters) up a glaciated valley to Carnivore Lakes, August 5, 1952. Mary Range on right.

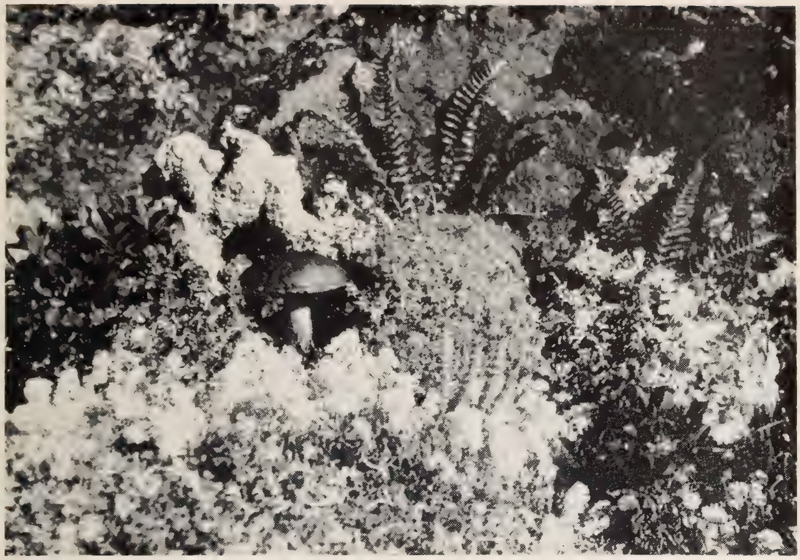


FIG. 1. Vegetation typical of protected places and of north slopes. The mushroom is approximately three inches high. Chandler Lake, 152°45′, 68°12′, 2900 ft., August 14, 1951.

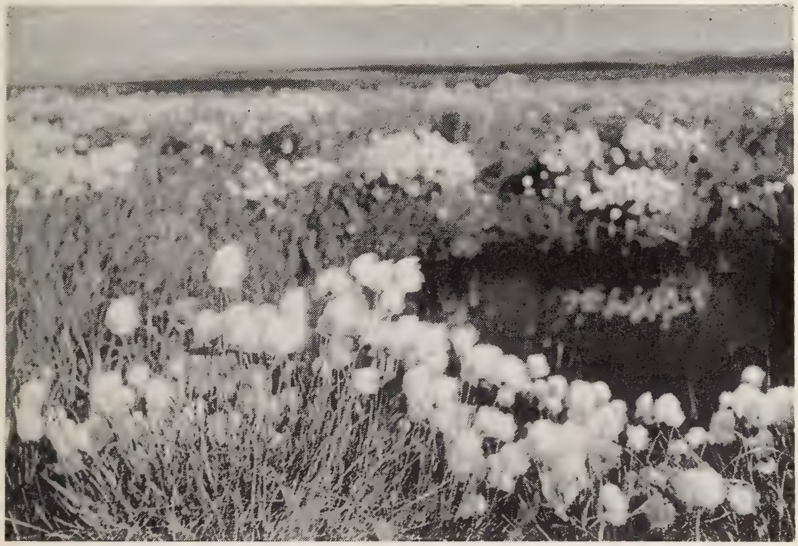


FIG. 2. Cotton-grass, *Eriophorum.* The collared lemming, *Dicrostonyx,* lived here. Kaolak River, 159°47′40″, 70°11′15″, 30 feet, July 12, 1951.

Plate 4

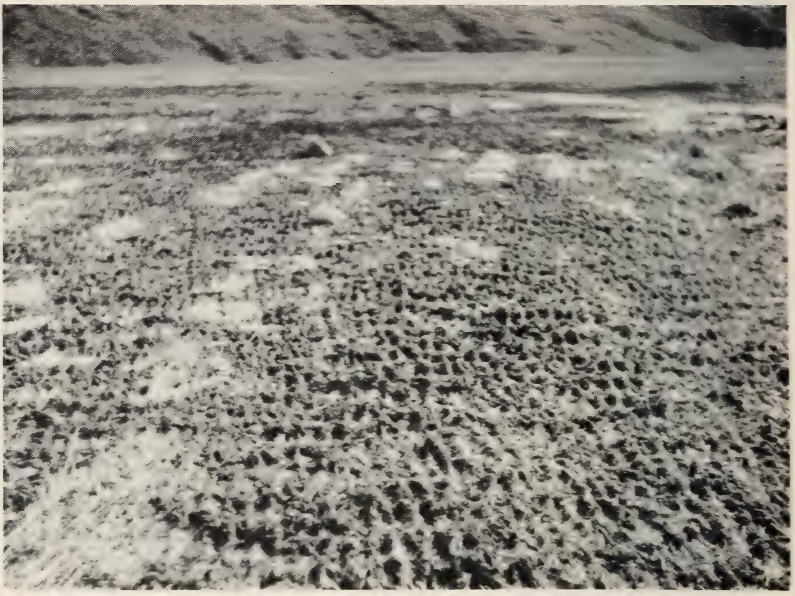


Fig. 1. Floor of west side of canyon at south end of Lake Peters, August 2, 1952. Note effect of hooves of approximately 6000 caribou which passed up this side of the canyon two weeks earlier.

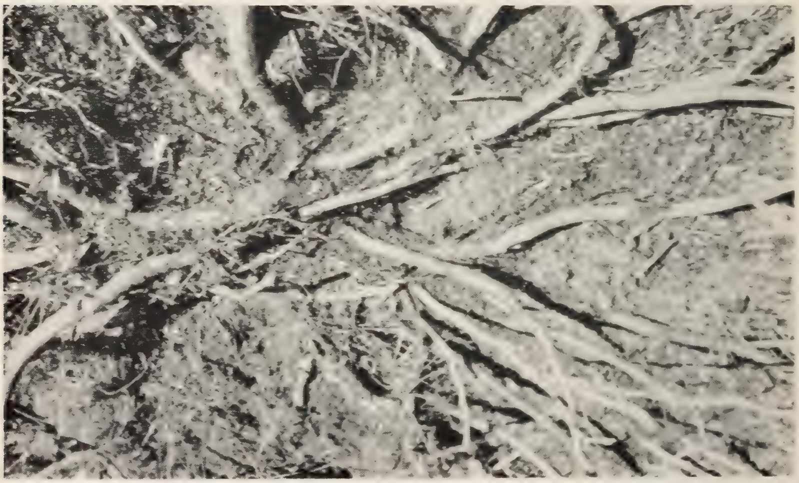


Fig. 2. Remains of willow (stems approximately one inch in diameter) on east side of south end of Lake Peters, August 5, 1952, showing effect of passage of part of 16,000 caribou two weeks earlier (July 19-22).

snow. Large lakes were open but smaller lakes were covered with ice.

Coastal Plain

The low Coastal Plain, of approximately 26,000 square miles, extends north from the undulating uplands of the Plateau Province to the Arctic Ocean. The eastern part of this low plain, near the international boundary, is less than 12 miles wide but south of Point Barrow it reaches a width of 100 miles and disappears on the west near Noakok on the coast of the Arctic Ocean. The average width from north to south is approximately 70 miles and the length from east to west is 550 miles. Most of the Coastal Plain is less than 50 feet above sea level but reaches elevations of from 200 to 500 feet at the southern boundary. Although generally described as flat, most of the lowland plains are marked by low broad ridges of aeolian origin and by mounds and hummocks formed in other ways. Depending on the locality, lakes cover 20 to 95 per cent of the ground surface and many of them are without drainage except when they overflow their basins in spring. The Colville River in the western part of the Coastal Plain intercepts the large rivers that flow from the Brooks Range and directs the water across the plains into one main channel. This diversion of the Brooks Range drainage has eliminated the usual deposition and stream erosion in the greater part of the Coastal Plain and has permitted the continued existence of thousands of lakes. Time has been sufficient for the development, by wave erosion, of oriented lakes having their long axes in a north-south direction, owing to erosion in the south ends of the lakes by wind blowing from the north in summer. These winds are not the prevailing winds—they blow in other directions—but are the winds that accompany the damaging storms that blow directly out of the north; they erode as much as two thirds of a meter of shore line in 24 hours. These oriented lakes have a great bearing on the ecology of the tundra, but not all lakes are aligned. Some adjacent lakes coalesce and form larger lakes. The long axes may be diagonal or even at right angles to the usual alignment. In size the lakes range from small ponds to those 20 miles long; they assume many different shapes. Common shapes are rectangular to elliptical. Most of the lakes are shallow but some are as much as eight meters deep and some are perhaps deeper in the centers. There are all stages of succession. Basins of old extinct lakes are not oriented and show that these earlier lakes did not exist long enough to be much affected by winds. Ice seals these lakes for almost 10 months of the year and winds are effective agents of erosion only in the short summer. Most lakes remain clear, but in windy weather some become muddy, especially around the edges. The most effective erosion takes place in spring when sheets of ice abrade south shores. Some lakes have successive stages of vegetation on only one side because the opposite edge of the lake is eroding into the area of old vegetation beside an adjacent lake. Differential uplift of part of the Coastal Plain is the best explanation of migration of the lakes.

Most rivers and streams are small, meander extensively, and some are interrupted and form oxbows. The large streams are grading to sea level and at contact with the Arctic Ocean fluctuate with the storm tides. Other streams, especially on the west coast, cut steep-walled channels through the sea cliff which in turn is being rapidly eroded by the Arctic Ocean. Flood waters in spring build up the flood plain and cause the tundra to slope downward from the edges of streams. Polygons form on these slopes and develop a series of steplike marshes, each polygon supporting water. The deposits along edges of streams and the exposed edges of lakes are the source of aeolian deposits. Wind carries these sands onto the tundra and builds long lines of sandy deposits 10 meters or more high. Sand storms are not infrequent during high winds.

Permafrost underlies the tundra to a depth of 1200 feet or more and its temperature falls to as low as —10.7°C. In winter, the ground freezes to the surface but in summer the active zone melts the permafrost down to a depth of 10 to 120 cms depending on the soils, exposure, drainage and climate. Immediately below lakes that do not freeze solidly, permanently frozen ground is lacking because of the insulation of the water. From this evidence, it seems logical to assume that the frozen ground is a product of post-Pleistocene times. Many land features are produced by permafrost, especially in areas of wet soils. As ground expands and contracts, it forms a fracture system in the soil; this system is expressed on the surface as a pattern of polygons. A polygon has four to nine sides. Once these fratcures are established, the surface water seeps down into them and with successive freezing and additional water the cracks or ice wedges are enlarged. During this process of enlarging, ground bordering the fractures is elevated above the wet soils and the surface area thus inclosed holds water. This process of soil elevation continues until the center of the polygon is raised and drainage is established along the original site of the fracture. There are many physical modifications of the soil associated with permafrost and they give the tundra character. The palatine pattern of transverse ridges which segment abandoned channels of water courses are typical. The area between two successive parallel ridges collects and retains water during periods of runoff. In autumn, when the upper surface of the zone of active permafrost

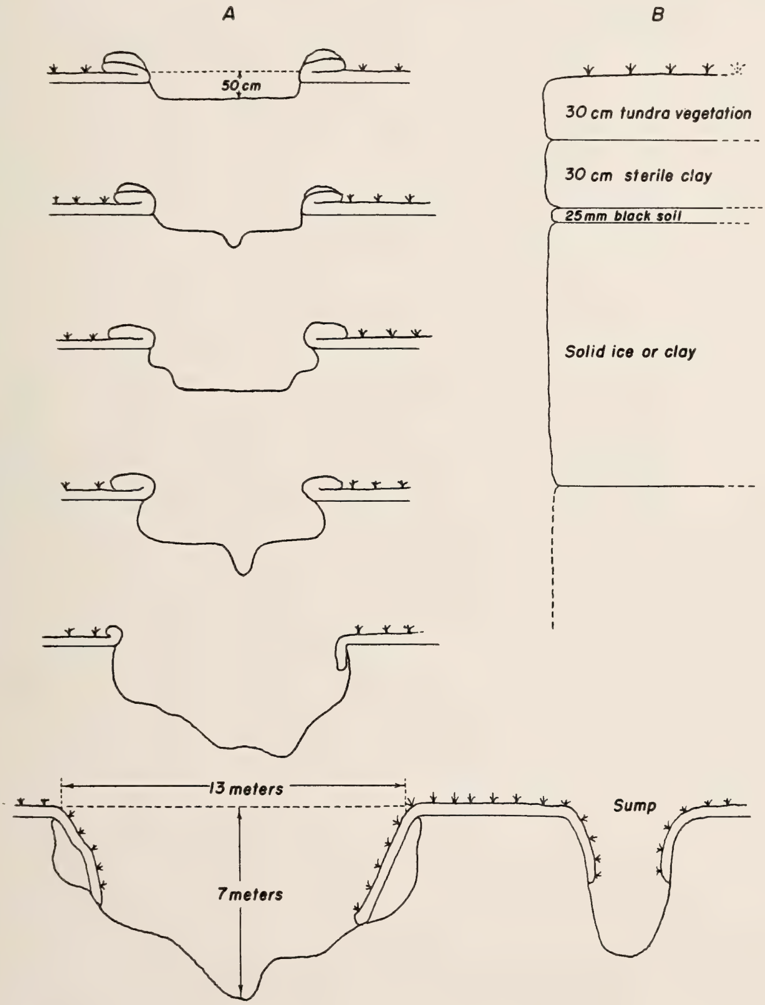

A
B
50 cm
30 cm tundra vegetation
30 cm sterile clay
25mm black soil
Solid ice or clay
13 meters
7 meters
Sump

FIG. 124. Cross-sections showing erosion in roadways which had been made at Kaolak by removing the tundra and upper layer of soil above the permafrost. Condition as of July 29, 1951. A. Stages in erosion. B. Profile of one side of deeply eroded roadway.

freezes and leaves a zone of unfrozen soils and water between the surface and the permafrost, mud may escape, especially if there is hydrostatic pressure in the unfrozen zone. If the upper layer of soil is resistant to the flow of mud, a mound of soil of considerable height is formed.

Man has created a serious erosional problem by removing the protective layer of tundra down to the level of the permafrost in constructing roads (see fig. 124). Within one year, roads on slopes have eroded to gullies three times their original widths and seven meters deep. The tundra, adjoining these roads, sinks—in places as much as five and a half meters in the first year.

The long winters are cold, clear, relatively calm and without sun for more than two months. The northern lights and light from the stars and moon is sufficient for normal activity except when the skies are overcast. Low mean temperatures are characteristic of the Coastal Plain and the Arctic Slope in general (see fig. 125) throughout the year. From November through April, at Barrow, the average of mean monthly-temperatures is —9.5°F. Only one-third of all the days in the year have maximum temperatures above freezing and five sixths have average minimum temperatures below freezing. In general the summers are colder and the winters are warmer than those inland on the Arctic Slope. On September 12, 1952, at the approach of winter in the northern part of the Coastal Plain, snow had collected around the edges of the lakes but the lakes proper were free of ice. Only small ponds and eddies of streams held ice. On this same date, in the southern part of the Coastal Plain, many of the small lakes were frozen and covered with snow but the tundra was free of snow. Snow, which covered the ground, on the Plateau formed a line at the junction of the Plateau Province and Coastal Plain regardless of altitude, suggesting a difference in insulating capacity of soils of the two areas. In winter at Topagaruk, which is on the Coastal Plain half way between the Plateau and the ocean, summers are cloudy, foggy, warm, continually lighted, free of ground snow and with moderate and variable winds. The average of means of monthly-temperatures from May through October is 30°F at Point Barrow. The annual precipitation is 4.23 inches, much of which falls as snow, sleet and hail. Although the area is a veritable desert, when thought of in terms of precipitation in lower latitudes, the low temperature, ineffective drainage, and slight evaporation combine to produce features characteristic of a more humid climate. The Arctic Ocean has a moderating influence on the climate of the mainland, especially in seasons when there is a wide difference between the temperature of the ice or water of the ocean and the temperature of the open tundra. Dense fogs develop in these periods. In spring, on June 14, 1952, in the southern part of the Coastal Plain, 80 per cent of the tundra beyond the edges of the lake was covered with snow. All the lakes were frozen; the ice was bluish and the lakes were sealed in around the edges and had snow in the centers.

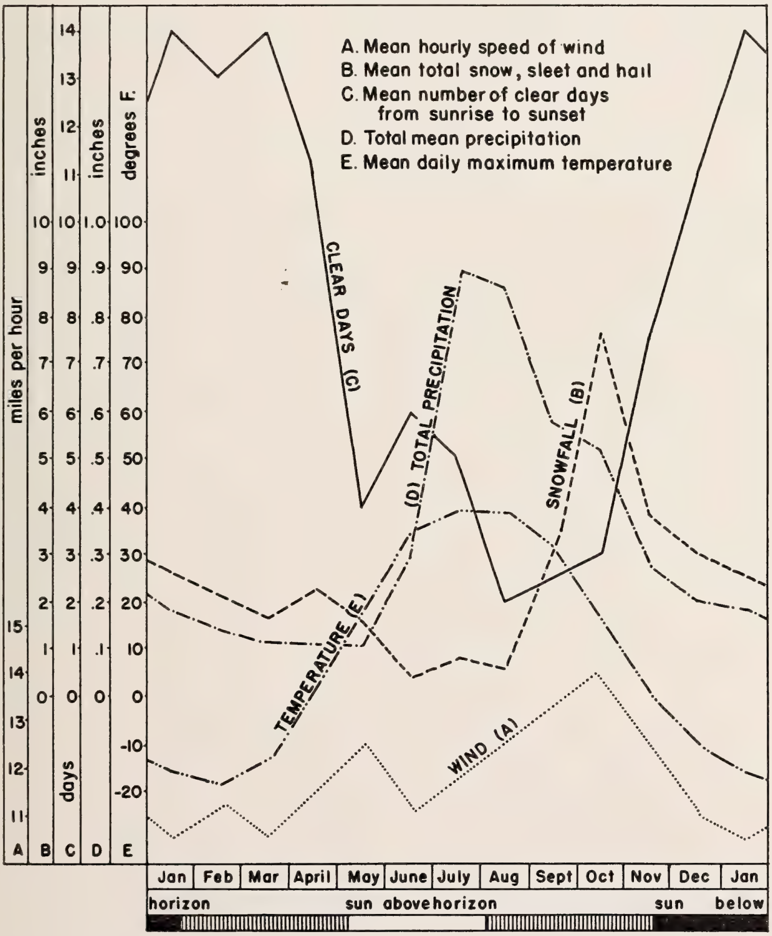


FIG. 125. Correlation of the means of temperature, total precipitation, snow accumulation, clear days, and wind velocities at Barrow, Alaska, from 1920 to 1951. Compiled from Local Climatological Summary, Weather Bureau, U. S. Department of Commerce, 1951.

The creeks were not open but the yellowish-brown water was staining the overhead covering of snow and was being discharged upon the ice around the edges of the lake, especially where the streams entered. Ridges of polygons were exposed but centers of polygons and fracture zones were filled with snow. From south to north the tundra showed increasing signs of the spring thaw except on the tundra adjacent to the Arctic Ocean where the snow cover was greater on the ground and on the ice of the lakes than farther inland. This snow had been blown in from the ice of the Arctic Ocean. The contact between the ocean and the mainland on this date was indistinguishable as far as snow coverage was concerned. On July 3 on the tundra between Point Barrow and the Plateau Province, three-fourths of the larger lakes supported ice. Some large lakes and all the small lakes were free of ice and the water was clear. There were occasional patches of snow on the tundra. Bays along the north edge of the Coastal Plain supported ice but no snow and were free along shore; water everywhere was muddy along shore. At Point Barrow the Arctic Ocean was free of ice beyond the pressure ridge to the west but was partly closed to the northeast. On July 8, 1951, between one and two a.m., ice started to move in the leads that were developing between the off-shore pressure ridge and the mainland. On a large lake at Topagaruk the ice decreased so much that on July 7 it covered only one-tenth of the surface of the lake instead of three-fourths of the surface as it did on July 5. Ice there was pushed on shore as late as July 7. As late as July 18, snow still remained on the beach at the base of the high erosional cliffs southwest of Barrow Village but the tundra was free of snow. The transition from summer to winter is accompanied by strong chilling winds, low temperatures, prolonged drizzling rains and light snows.

NORTHERN ARCTIC SLOPE *VERSUS* SOUTHERN ARCTIC ALPINE AREAS

In general features the tundra on the Arctic Slope resembles that on high Arctic alpine areas in temperate regions, but wide range and extremes of temperature within the daily cycle in Arctic alpine areas *versus* uniformity in temperature on the Arctic Slope is a fundamental difference. Furthermore, permafrost in the soil on the Arctic Slope keeps water on the surface of the ground and permits extension of sedges and grasses onto many slopes that, in alpine areas, are dry and generally well drained. Permafrost does not, however, exclude mammals from living on the tundra of the Arctic Slope. The light fall of snow there is drifted by winds of high velocity which expose part of the tundra. Mammals are able to move about in winter on the Arctic Slope while in the Arctic alpine areas, say, in the United States, the deep snow excludes the larger and many of the smaller mammals. The foliose lichens attain their optimum development on the Arctic Slope and seldom reach an equivalent stage of development in the Arctic alpine areas, because of differences in the quality of the climate in the two regions. Presence or absence of mosses and lichens has less effect on mammals than does the presence or absence of sedges and grasses. Mosses and lichens form a protective layer in which small mammals build runways and nest. This layer decomposes less on the Arctic Slope than in the Arctic alpine areas to the south.

The Arctic Slope is a broad and continuous ecotone between the coniferous forests and the more northern lands that support principally lichens and mosses. This ecotone is characterized by great expanses of terrain whereas in the Arctic alpine areas this ecotone, because of the physiography of the mountains, is generally of limited extent and in many places occupies a zone less than a hundred feet in vertical extent on the side of the mountain. The major part of the ecotone, made up by the Arctic Slope, is far removed from coniferous forests and there is less seasonal movement of mammals from the slope to the forests than there is from the Arctic alpine areas to coniferous forests. The differences enumerated above, permit the survival of more kinds and numbers of mammals on the Arctic Slope than on the Arctic alpine areas farther south.

BIOTIC COMMUNITIES

The biotic communities on the Arctic Slope are between the coniferous forests on the south side of the Brooks Range and the Arctic Ocean on the north. These communities are notable for the unusual habitat, both post-Pleistocene and Recent, and for the periodic overgrazing of the vegetation by the caribou and the brown lemming.

The *Carex-Microtus oeconomus* association has the sedge, *Carex aquatilis,* as the dominant plant and the tundra vole, *Microtus oeconomus,* as the major influent. This association is in an early stage of the hydrosere and occurs in the wettest places, in areas of low elevation in the major drainage systems and around large

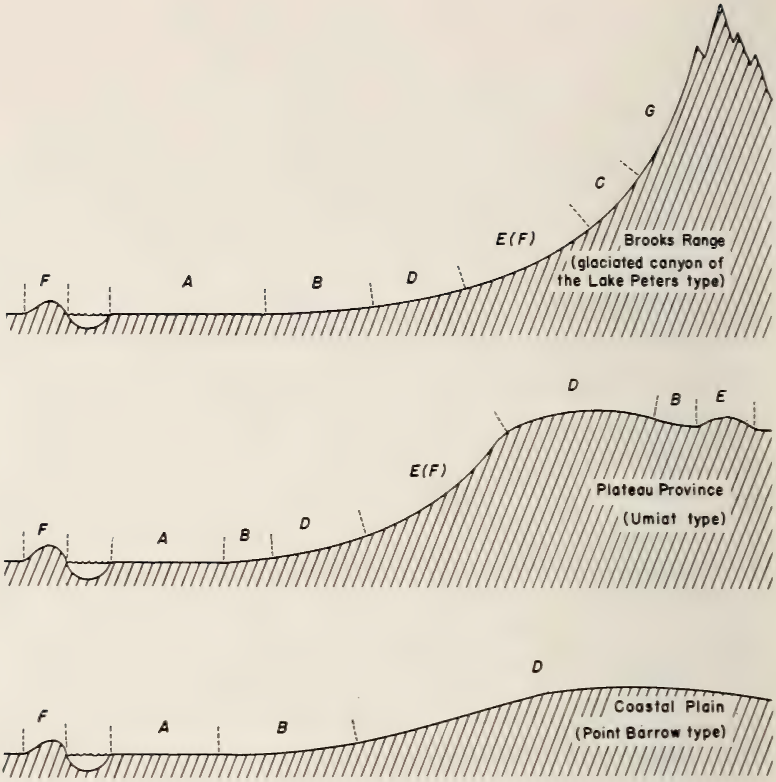

G
C
E(F)
Brooks Range
(glaciated canyon of
the Lake Peters type)
F
A
B
D
D
B
E
E(F)
Plateau Province
(Umiat type)
F
A
B
D
D
Coastal Plain
(Point Barrow type)
F
A
B

FIG. 126. Biotic associations on the Arctic Slope of Northern Alaska.

A *Carex–Microtus oeconomus*
B. Meadow grass (damp)–*Lemmus*
C. Forb–*Marmota*
D. *Eriophorum–Dicrostonyx*
E. *Betula–Clethrionomys*
F. *Salix* (riparian)–*Microtus miurus*
G. Meadow grass (dry)–*Ovis–Rangifer*

bodies of permanent water of constant level. In the Brooks Range, and on the Plateau, the tundra vole lives principally on the floors of canyons although benchlands and solifluction terraces that support many carices are available on sides of canyons. Subdominant plants are *Arctogrostis latifolia* (R. Br.) Griseb. and *Arctophila fulva.* Associated directly with the dominant and subdominant plants are *Carex physocarpa* Presl., C. *lugens* Holm, *C. Kelloggii* W. Boott, *C. podocarpa* R. Br., *Poa arctica* R. Br., *Poa glauca* Vahl, *Festuca scabrella* Torr., *Calamogrostis neglecta* (Ehrh.) Gaertn.

Meyer and Schreb. inter. with *C. purpurascens* R. Br. and *Trisetum spicatum* (*L.*) Richt. Other sedges (*Carex*) become dominant along running water. The tundra vole is in direct competition with the brown lemming in the southern part of the Arctic Slope and is a major influent there whereas in the northern part of the Coastal Plain the tundra vole is sub-influent or absent. The cinereous shrew and least weasel, of the smaller mammals, are commonly found in this association.

The meadow grass (damp)-*Lemmus* association consists of several species of grasses as the dominant plants and the brown lemming, *Lemmus trimucronatus,* as the major influent mammal. This association is an intermediate seral stage of the hydrosere and is best developed where there are damp soils on the low Coastal Plain, where the association covers the greater part of the surface of the ground on the low lying terrain around lakes and in swales between ridges or other areas of higher relief. Damp soils support more grasses and forbs than sedges. Grasses that are dominant in varying degree are *Poa arctica* R. Br., *Hierochloe alpina* (Swartz) Roem. and Schult., *Luzula confusa* Lindb., *Alopecurus alpinus* J. E. Smith, *Calamogrostis neglecta* (Ehrh.) Gaertn. Meyer and Schreb. inter. with *C. purpurascens* R. Br., *Calamogrostis canadensis* (Michx.) Beauv., *Poa glauca* Vahl, *Festuca scrabella* Torr., and *Trisetum spicatum* (L.) Richt. Sphagnum mosses dominate lichens in the early stages of the hydrosere.

The forb-*Marmota* association consists of several species of forbs as the dominant plants and the hoary marmot, *Marmota caligata,* as the major influent. In the Brooks Range this association is a late converging sere of the xerosere and hydrosere and is best developed on damp soils on canyon slopes where vegetation is partly protected from winds. Common plants are *Saxifraga, Therofron richardsonii, Lupinus, Potentilla, Salix,* mosses and lichens. In the Brooks Range the marmot feeds on vegetation of this association and uses rock slides for protection and hibernation. The ermine, Arctic ground squirrel and Dall sheep frequently live in this association.

In the *Eriophorum-Dicrostonyx* association the cotton-grass, *Eriophorum,* is the dominant plant and the collared lemming, *Dicrostonyx,* is the major influent. Sedges, other than *Eriophorum,* grasses and some forbs are also present. Conspicuous lichens, usually growing on low protected sides of hummocks of *Eriophorum,* are: *Sphaerophorus globosus* (Huds.) Vainio, *Cladonia rangiferina*

(L.) Web., *Ochrolechia frigida* (Sw.) Lynge, *Peltigera aphthosa* (L.) Willd., *Dactylina arctica* (Hook.) Nyl., *Nephroma arcticum* (L.) Torss., *Alectoria nigricans* (Ach.) Nyl., some *Cetraria nivalis* (L.) Ach., and *C. cucullata* (Bell.) Ach. This association is the sereclimax of the hydrosere and is best developed on undulating uplands of the Plateau Province and on ridges above lowlands on the Coastal Plain. Permafrost causes uplands to hold some water on or near the surface and prevents communities from reaching a climatic climax. Most of the water drains off the gentle slopes of these uplands, and thus prevents permanently saturated soils. The hummocks of cotton-grass, which are spaced close together and are generally separated by bare soils, increase their height by building up a mat of dead material. The undecayed plants form a mat, rather than deep soils. Lower protected sides of hummocks are covered with mosses and lichens. These lichens seem to be subdominant and of only secondary importance to the collared lemming. If hummocks of cotton-grass are elevated by action of permafrost and if better drainage is established or if sterile clay, which is continually being brought to the surface by action of the permafrost, covers the ground between hummocks of cotton-grass the *Eriophorum-Dicrostonyx* association looses its identity; the sedges die and are replaced by mosses and lichens. These elevated areas later become heaths. Farther to the north, lichens become dominant and grow independently of the cotton-grass. Rodents dig nest chambers and burrows in the basal parts of the cotton-grass-hummocks which in summer are relatively free of permafrost. In the Brooks Range this association has a limited distribution because steep mountains preclude the development of this association.

The *Betula-Clethrionomys* association has the dwarfed birch, *Betula nana,* as the dominant plant and the red-backed vole, *Clethrionomys rutilus,* as the major influent. This association is a late stage of the xerosere and is the edaphic subclimax on the Arctic Slope. This association reaches its optimum development on the southern part of the Arctic Slope and becomes progressively less dominant from south to north. In the Brooks Range this subclimax occupies the lower dry slopes of canyons and less stabilized moraines and boulder fields that have been sealed in by previous seral stages. The soils are well drained and exposed to light and wind. Boulder fields are the areas last to be sealed in by vegetation. After they are sealed, these places are heaths; moisture runs off and sinks, making a dry edaphic condition that prevents the grass climax from finding full expression. Other plants on the heath give overhead protection to the foliose lichens. On the coastal plain heaths occur only in the southern part. The kinds of lichens that grow in these heaths maintain themselves independently farther north. A heath frequently develops where there were sphagnum mosses in the succession of the hydrosere. Heaths are principally responsible for the brilliant red color of autumn. In 1951 in the Brooks Range, color appeared on August 1. *Cassiopia tetragona, Ledum, Vaccinium vitis-idea, Empetrum, Dryas octopetala,* mosses and lichens are subdominant to *Betula.* The conspicuous lichens which grow mainly on the exposed slopes of this association are: *Cetraria islandica* (L.) Ach., *Cladonia gracilis* v. *chordalis* (Flk.) Schaer. and to a lesser extent *Cladonia sylvatica* (L.) Hoffm. Lichens that grow on north exposures and on slopes protected from strong winds include the above named species and the following:

Stereocaulon paschale (L.) Hoffm., *Cladonia amaurocraea* (Flk.) Schaer., *C. a.* var. *oxyceras* (Ach.) Wain., *C. rangiferina* (L.) Web., *C. pyxidata* (L.) Hoffm., *C. coccifera* (L.) Willd., *C. alaskana* Evans, *C. verticillata* (L.) Hoffm., *C. v.* var. *cervicornis* (Ach.) Flk., *C. alpestris* (L.) Rabh., *Thamnolia vermicularis* (Sw.) Schaer., *Alectoria nitidula* (T. Fr.) Vain., *Cetraria nivalis* (L.) Ach., *C. cucullata* (Bell.) Ach., *C. chrysantha* Tuck., *C. richardsonii* (Hook.) Tuck., *Dactylina arctica* (Hook.) Nyl., *Parmelia separata* Th. Fr., *P. omphalodes* Ach., *P. centrifuga* (L.) Ach., *P. sulcata* Tayl., *Sphaerophorus globosus* (Huds.) Vain., *S. fragilis* (L.) Pers., *Rhytidium rugosum* (Hedw.) Kindb., *Peltigera membranacea* (Ach.) Nyl., *P. polydactyla* (Neck.) Hoffm., *Lobaria linita* (Ach.) Rabh., *Alectoria lanea* (Ehrh.) Vain., *Nephroma arcticum* (L.) Torss. *Salix* frequently grows on heaths. The grizzly bear, wolf and red fox have been seen hunting in this association.

The *Salix* (riparian)-*Microtus miurus* association has the dwarfed willow, *Salix,* as the dominant plant and the singing vole, *Microtus miurus,* as the major influent mammal. This association is an early xerosere of either the dry, well drained sandy soils deposited by overflowing streams or new soils that have been exposed along edges of lakes, or on alluvial fans. So far as providing a place for animals to live, the seral nature and edaphic nature of the soils are more important than degree of drainage. The plant and animal association varies according to the nature of adjoining associations. *Alnus, Equisetum, Poa arctica, Festuca altaica, Calamogrostis* and *Taraxacum lacerum* are subdominant to *Salix.* The wolf, dusky shrew, ermine, red fox, wolverine, porcupine and grizzly bear are influents of varying degree in this association.

In the meadow grass (dry)-*Ovis-Rangifer* association, grasses are the dominant plants, and the Dall sheep (*Ovis dalli*) and the barren-ground caribou (*Rangifer arcticus*) are the major influents. On the Arctic Slope, this association is probably a preclimax or postclimax. In the Brooks Range the grass climax is the climax of the xerosere and occurs on stabilized slopes and ridges above the glaciated canyons and generally above heaths, especially on south exposures where soils are dry and firm and are not covered by a mat of undecayed plant-remains. Lichens are dominant on north exposures. Also on lower slopes, grasses replace heaths (dwarf willow and dwarf birch) and grow among forbs on damper soils. Concentrated grazing and repeated trampling by caribou, in many places on the Arctic Slope, are responsible for the life-form of vegetation. These places are in contrast to the areas protected by physical barriers from caribou. These ungrazed or untrampled areas support high grasses. Immediately below overhanging ledges, where fecal droppings of Dall sheep have developed a rich soil, grasses are the dominant plant, even high in the mountains where the altitude otherwise permits only a sparse growth of mosses and lichens. Some of the dominant grasses of the climax in the Brooks Range are: *Trisetum spicatum* var. *molle.* (Michx.) Beal, *Poa glauca* Vahl, *Bromus arcticus* Shear., *Hierochloe alpina* (Swartz) *Roem.* and Schult., *Festuca ovina* (L.), *Calamogrostis purpurascens* (R. Br.) and *Alopecurus alpinus* J. E. Smith. On the Coastal Plain, grasses grow where soils are being formed. The Eskimo mounds at Birnirk support grasses because soil there was enriched by the Eskimos' use of the mounds for many generations. Pete Sovalik and other Eskimos who have lived at Barrow Village most of their lives told us that as long as they remember, these mounds have supported luxuriant grasses. Grass is dominant also in areas southwest of Barrow Village where by-products of former Eskimo habitation have enriched the soils. In the Point Barrow area, grasses are maintained on stabilized soils made by action of the waves. Although the caribou occurs in all three physiographic provinces, the Dall sheep occurs only in the Brooks Range.

Lakes on the Arctic Slope are youthful and support only small amounts of vegetation. Many of the lakes, however, especially in the Brooks Range, have a rich fauna of fishes and invertebrates. It is not known why these lakes are not used by aquatic mammals. Seals and the harbor porpoise inhabit the lower parts of rivers flowing into the Arctic Ocean.

The marine associations are little known. The bowhead whale is perhaps one of the most important major influents in open marine waters and the polar bear is a major influent on the ice packs. Several species of seals are common along the mainland coast.

ITINERARY

Camps and collecting localities on the Arctic Slope of northern Alaska in 1951 and 1952 (Bee and Jones, July 3-September 6, 1951; Bee, September 6-11, 1951; Bee and Campbell, June 14-August 25, 1952; Bee, Campbell, and Hall, August 26-September 12, 1952) were as shown in Fig. 127.

Camps, and localities in the vicinity of each camp, are arranged geographically from north to south. The localities listed below under camps are only those which one or more of us (Bee, Campbell, Jones and Hall) visited. Travel between camps was by airplane; heavy black lines show routes followed.

Point Barrow (1951: July 3-5, 10-12, 18-20, 27-29, Aug. 5-7, 28-30, Sept. 4-11.——1952: June 14-24, Aug. 23-27, Aug. 31-Sept. 12). Longitudes and latitudes taken from U. S. Coast and Geodetic Survey map No. 9445, 2nd edition, Point Barrow and vicinity, corrected May 21, 1951.

Point Barrow, 156°27′25″, 71°23′11″, 3 ft. (June 20, 21, Aug. 25, 1952).
Point Barrow, 156°30′00″, 71°22′10″, 0 ft. (Sept. 11, 1952).
4½ mi. SW Point Barrow, 5 ft. (Sept. 7, 8, 1951), but in the second year (June 14, 16, 1952) specimens from this same place were inadvertently labeled at "Birnirk Mounds, 156°36′02″, 71°20′40″, 8 ft.".
NW Elson Lagoon, 156°35′45″, 71°20′27″, 0 ft. (Sept. 2, 1952).
Point Barrow, 156°40′40″, 71°19′30″, 8 ft. (Sept. 9, 1952).
Point Barrow, 156°35′45″, 71°19′30″, 8 ft. (Sept. 9, 1952).
Point Barrow, 156°39′40″, 71°19′03″, 6 ft. (Sept. 3, 4, 7, 8, 1952).
West side Salt Water Lake [Lagoon], 156°42′00″, 71°18′41″, 4 ft. (June 18, 19, 1952).
1/10 mi. W Salt Water Lake [Lagoon], 156°42′02″, 71°18′26″, 10 ft. (June 16-19, 1952).
9/10 mi. E and 8/10 mi. N Barrow Village, 156°44′15″, 71°18′20″, 8 ft. (June 22, 23, 1952).
1 4/10 mi. S and 6/10 mi. E Barrow Village, 156°45′25″, 71°16′20″, 20 ft. (June 20, 1952).

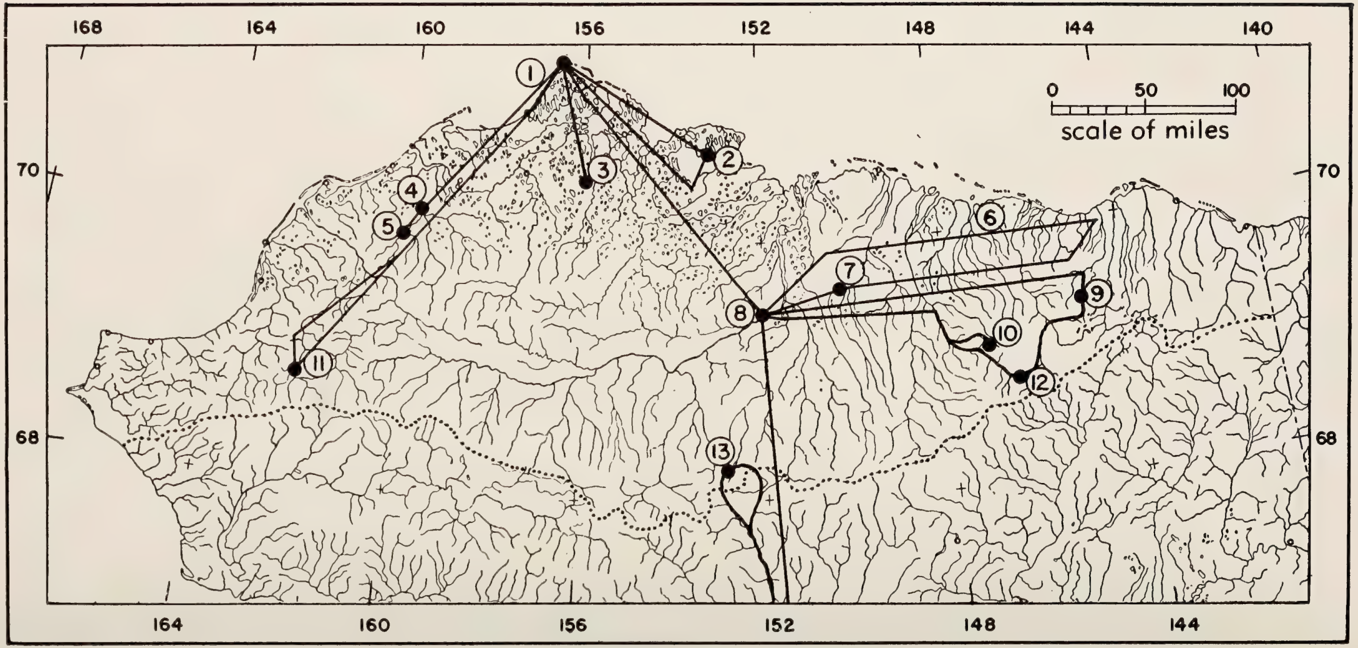
Teshekpuk Lake (1951: July 29-Aug. 4). Shown on a map, titled "Trails and Caches 1951 Season, Naval Petroleum Reserve No. 4,. . .traced and reproduced from U. S. Geological Survey Maps, March 1945, compiled from AAF Trimetrogon photography for Aeronautical Chart Service."

NE Teshekpuk Lake, 153°05′40″, 70°39′40″, 12 ft.

Topagaruk (1951: July 5-10). Named on map "Trails and Caches 1951. . ." cited immediately above, but is actually seven miles due south of name shown on that map. Correct position is 155°55′, 70°34′, 10 feet; but specimens are incorrectly labeled 155°48′. . . .

Kaolak River (1951: July 12-18). River shown on map cited above under Teshekpuk Lake.

[Actual camp on] Kaolak River, 159°47′40″, 70°11′15″, 30 ft.


168
164
160
156
152
148
144
140
70
68
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scale of miles
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Fig. 127. Routes of travel and base camps of field party in 1951 and 1952.

1. Point Barrow
2. Teshekpuk Lake
3. Topagaruk
4. Kaolak River
5. Kaolak
6. Reconnaissance flight
7. Gavia Lake
8. Umiat
9. Lake Schrader–Lake Peters
10. Wahoo Lake
11. Driftwood
12. Porcupine Lake
13. Chandler Lake

Kaolak, (1951: July 20-27). Longitude and latitude computed from map cited above under Teshekpuk Lake.

Kaolak, 160°14′51″, 69°56′00″, 178 ft.

Gavia Lake (Aug. 19-23, 1952). Longitude and latitude computed from World Aeronautical Chart (63) Brooks Range, U. S. Coast and Geodetic Survey, 5th ed., February 2, 1949.

Gavia Lake, N White Hills, 150°00′, 69°35′, 460 ft. (Gavia is the name here applied to the previously unnamed lake.)

Umiat (1951: Aug. 30-Sept. 4.—1952:June 24-July 3, 18-23, Aug. 16-19, 23, Sept. 12). Longitude and latitude taken from U. S. Geological Survey Topographic Map.

Bearpaw Creek, $1\frac{7}{10}$ mi. E and $1\frac{7}{10}$ mi. N Umiat, 152°04′50″, 69°23′ 30″, 550 ft. (June 28, 1952.)

$1\frac{3}{10}$ mi. E and $1\frac{3}{10}$ mi. N Umiat, 152°05′30″,69°23′12″, 350 feet. (June 26, 27, 1952.)

$\frac{9}{10}$ mi. W and $\frac{9}{10}$ mi. N Umiat, 152°10′58″, 69°22′53″, 380 ft. (June 29, 30, July 1, 1952.)

1 ½ mi. W and ¾ mi. N Umiat, 152°08′10″, 69°22′18″, 370 ft. (Aug. 30, Sept. 4, 1951.)

Umiat, 152°08′, 69°22′, 337 ft. (Aug. 19, 1952.)

Umiat, 152°09′30″, 69°22′08″, 352 ft. (June 24, 26, July 21, 22, 1952.)

As shown on fig. 127 a reconnaissance flight was made from Umiat to Sadlerochit River and return (July 22, 1952).

Lake Schrader-Lake Peters (July 23-Aug. 16, 1952). Longitudes and latitudes taken from map entitled "Preliminary Copy", U. S. Petroleum Reserve No. 4, U. S. Geological Survey, March 1948, scale 1-6900.

Spawning Creek, W side Lake Schrader, 145°11′40″, 69°25′08″, 2908 ft. (Spawning is the name here applied to the previously unnamed creek.) (July 27, 28, 1952.)

SW Lake Schrader, 145°11′30″, 69°24′32″, 2925 ft. (July 27, 28, 1952.)

Lake Schrader, 145°09′50″, 69°24′28″, 2900 ft. (July 23, 24-30, 1952.)

East side Lake Schrader-Lake Peters Channel, 145°09′30″, 69°24′15″, 2905 ft. (July 29, 30, 1952.)

Mouth Chamberlin Canyon, S end Lake Peters, 145°08′34″, 69°20′58″, 3690 ft. (Aug. 4, 5, 1952.)

SE end Lake Peters, 145°09′26″, 69°20′56″, 2950 ft., Romanzof Mountains. (Aug. 1-9, 14, 1952.)

Mount Mary, S end Lake Peters, 145°10′05″, 69°20′35″, 3012 ft. (Mary is the name here applied to the mountain in the Mary Range—also a new name—between Carnivore River on the east, Whistler Creek on the west, mouth of Whistler Creek on the north, and the crest of the Brooks Range on the south.) (Aug. 13-16, 1952.)

Mount Mary, S end Lake Peters, 145°10′02″, 69°20′30″, 2920 ft. (July 30-Aug. 11, 1952.)

S end Lake Peters, 145°09′50″, 69°20′15″, 2906 ft. (Aug. 15, 1952.)

Weasel Point, S end Lake Peters, 145°09′30″, 69°20′15″, 2920 ft. (Weasel is the name here applied to the previously unnamed ridge of Mount Mary; the ridge is a resistant stratum dipping to the east.) (Aug. 9-11, 1952.)

Carnivore Lakes (Carnivore is the name here applied to the three previously unnamed lakes at elevations of 3260, 3385 and 3400 ft. between 69°18′ and 69°17′ on Carnivore River (new name) which flows from James Robert Lake to Lake Peters). (Aug. 8, 1952.)

James Robert Lake, 145°10′00″, 69°16′30″, 2600 ft. (James Robert is the name here applied to the previously unnamed lake.) (Aug. 8, 1952.)

James Robert Glacier, 145°09′, 69°16′, approximately 3700 ft. (New name employed for first time.) (Aug. 8, 1952.)

Wahoo Lake (July 3-11, 1952). Longitude and latitude taken from map entitled "Preliminary Copy", Naval Petroleum Reserve No. 4, U. S. Geological Survey (of same series as map used at Porcupine Lake, see below).

Wahoo Lake, 146°58′, 69°08′, 2350 ft.

Driftwood (Aug. 27-31, 1952). Longitude and latitude computed from map cited above under Teshekpuk Lake.

2 mi. W Utukok River, 161°15′30″, 68°54′50″, 1275 ft. (Aug. 30, 1952.)

Driftwood, Utukok River, 161°12′10″, 68°53′47″, 1200 ft. (Aug. 27-31, 1952.)

Porcupine Lake (July 11-18, 1952). Longitude and latitude computed from map titled "Preliminary Copy", Naval Petroleum Reserve No. 4, compiled by U. S. Geological Survey, May, 1949, Alaska, K6, scale 1:4800.

Porcupine Lake, 146°29′50″, 68°51′57″, 3140 ft. (July 12-16, 18, 1952.)

Mount Annette, 146°28′51″, 68°50′38″, approximately 5700 ft. (Mount Annette is the name here applied to the previously unnamed mountain in the Annette Range—also a new name—south of Porcupine Lake between the Canning River and the Ivashak River.) (July 17, 1952.)

Chandler Lake (Aug. 9-25, 1951). Longitude and latitude taken from World Aeronautical Chart (63) Brooks Range, U. S. Coast and Geodetic Survey, 5th ed., February 2, 1949.

Chandler Lake, 152°45′, 68°12′, 2900 ft.

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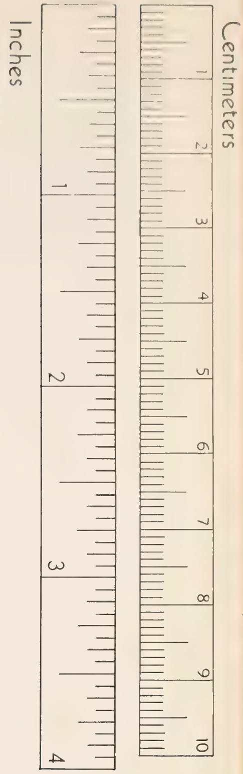

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